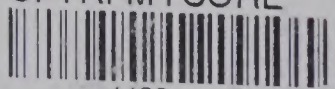


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INFANT FOODS AND FEEDING PRACTICE



# INFANT FOODS AND FEEDING PRACTICE

(A Rapid Reference Text of Practical  
Infant Feeding for Physicians and Nutritionists)

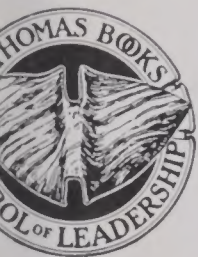
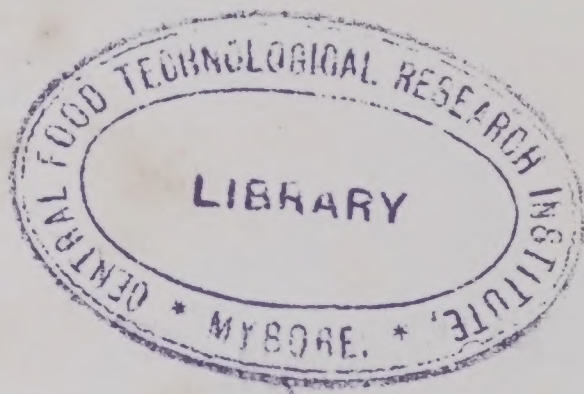
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*To all physicians and physicians-to-be who hold firmly to superior standards of personal integrity and intellectual honesty despite inevitable conflicts with political expediency, social opportunism and monetary competition in their professional pursuits — to these, the steadfast majority of the medical profession — this book is respectfully dedicated.*



## FOREWORD

THE CARE afforded an infant or a child should conform to the individual's specific needs. Proper nutrition is a most important aspect of infant care. The fundamentals of proper infant nutrition and the summary of the most desirable procedures available to achieve this are in themselves not complex, despite the large number of special foods developed for infant feeding. These have been marketed to permit individualization in infant care once his needs have been determined. Thus, the physician has available milk mixtures and other foods designed to meet almost every situation in the maintenance of health or in the treatment of disease.

In this book, the fundamentals of infant nutrition are reviewed first as the basis for the discussion of current concepts in infant feeding practices. The sequence of presentation and the development of each subject are excellent. Although the author devotes considerable attention to the problems often encountered in breast feeding, perhaps his most valuable contribution is to be found in his classification of infant foods, especially milk mixtures.

This concise, but complete discussion and classification, along with a thorough review of common problems encountered in infant care should make this book a valuable reference for the physician.

PHILIP L. WHITE, Sc.D.  
*Secretary*  
*Council on Foods and Nutrition*  
*American Medical Association*  
*Chicago*



## Frontispiece

### A SIMPLE SAGA OF INFANT FEEDING

Soranus, he of ancient Rome,  
He had a simple trick  
To see if milk was fit for sale,  
He merely dropped it on his nail  
To see if it would stick;  
Yet 'spite of this the babies grew,  
As any school boy'll tell to you.

Good Metlinger in ages dark  
Just called milk good or bad.  
No acid milk to vex his soul;  
He gave it good, he gave it whole,  
A method very sad;  
Yet babies grew to man's estate,  
A fact quite curious to relate.

Time sped, and Science came along  
To help the human race;  
Percentages were brought to fame  
By dear old Rotch, (of honored name)  
We miss his kindly face;  
Percentages were fed to all—  
Yet babies grew, both broad and tall.

The calories now helped us know  
The food that is required.  
Before the baby now could feed  
We figured out his daily need—  
A factor much desired;  
Again we see with great surprise  
That babies grow in weight and size.

The vitamin helps clarify  
Why infants fail to gain;  
We feed the baby leafy food  
Which for the guinea pig is good—  
A reason very plain;  
And still we watch the human race  
Go madly at its usual pace.

We have the baby weighed today;  
The nursing time is set,  
At last we find we are so wise  
We can begin to standardize—  
No baby now need fret;  
In spite of this the baby grows,  
But why it does God only knows!

Away with all such childish stuff!  
Bring chemists to the fore!  
The ion now is all the rage.  
We listen to the modern sage

With all his latest lore;  
And if the baby fret or cry,  
We'll just see how the ions lie!

*The pendulum swings back again—  
Great-grandmas have their say.  
"Feed any hour or any time,"  
To let them cry is now a crime—  
It's 'ad lib' feeding's day!  
"Security"—The Clarion Call  
From Ivory Towers, stern and tall!*

*A controversy shows its head—  
Shall early solid foods win out?  
Feed them meat and feed them bread—  
It's a gastronomic race instead!  
Nutrition's rules—"To Route!"  
Yet fewer babies seem to die  
And more and more they multiply.*

*Science to the front once more!  
Solute loads are scanned;  
The carbohydrate is at bay—  
In babies' milk it is passé  
And oft' may be completely banned!  
Synthetic mixtures hold sway now,  
And soon they'll say—"Who needs a  
cow?"*

*Amino acids are "the rage";  
'N balance' is in fashion;  
Which Fats are best—do all agree  
With neonates' gastronomy?  
What is a balanced ration?  
Yet Man continues to succeed  
In making Him the leading breed.*

*Breast Feeding! Ah—that ancient art  
Is losing out, it seems—  
"The female breast is for display!"  
"Utility be damned!"—they say,  
(It may be just a dream).  
While no one asks the babies' choice—  
Proprietary firms rejoice!*

*A hundred years will soon go by;  
Our places will be filled  
By others, who will theorize  
And talk as long and look as wise  
Until they too are stilled;  
And I predict no one will know  
What makes the baby gain and grow!*

(See overleaf)

(The past history, present status and future extent of infant feeding are projected in the foregoing poem. It was written by the late Dr. John Rühräh—philosopher, teacher, poet, pediatricist and able historian. In its gentle satire Dr. Rühräh infers that the final conclusions to the art and science of infant feeding have not, as yet, been recorded—a propitious portent for this book, *Infant Foods and Feeding Practice*. The stanzas in italics were humbly added by the present author to bring to light the more recent episodes of this quaint thumbnail history. Apologies are offered to the memory of the original author for probable errors in metre and a presumptuous poetic license.)

H.F.M.

## PREFACE

**I**N THIS compact manual of infant feeding, a sincere effort is directed toward the application of the practical principles of chemistry and physiology pertaining to the art and science of infant nutrition. It is designed for the physician, to whose lot falls the responsibility of directing the feeding of most well infants. It has been observed that most practitioners, internes and even residents are of the opinion that they never have been adequately prepared for this phase of their care of infants when it is known that 60 to 80 per cent of the baby-care portion of any practice consists in the routine feeding of well infants. It is hoped that this text of essential facts may help to allay that deficiency of the medical curricula.

No apology is offered for the elemental tone which pervades some portions of the text. In addition to the presentation of the essentials of infant feeding facts in compact form for the experienced physician, this book is also a primer and digest, written for the neophyte in his introduction to the subject. The temptation to become didactic is ever present in the preparation of data on infant feeding. Studied effort is made to avoid the dogmatism and arbitrary directives which would violate the vital premise on which successful and individual infant feeding is based.

Throughout the text there is an air of repetitiveness which is unavoidable. Because this is mainly a reference book, few persons will attempt to read the sections consecutively. Thus certain facts which seem important bases of infant feeding are repeated in the light of the section or chapter under discussion. This is one of the licenses which an author assumes in order to emphasize favorite topics or to drive home that which he deems valuable in the field.

Without attempting to escape the responsibility which authorship of the printed word often implies, the reader is reminded that the clinical opinions expressed and often repeated in minor controversial areas is still the opinion of but one clinician and

must be accepted with this well in mind. In spite of being forcibly articulate or persistently argumentative, there is still room for further interpretation and opinion.

No presumption is made by the author of being an expert in the field of nutrition—the almost two hundred references herein quoted would effectively document this fact. The allusions through the text of the applied data of practical information have been gleaned for over 30 years in directing of infant feeding in private pediatric practice, in the hospital outpatient department, in Infant Welfare Stations, and at the crib-side of the sick infant in a children's hospital. It is repeated that the opinions stated in the text do not necessarily concur with those of members of institutions with which the author is associated.

\* \* \*

The enthusiasm with which the first text—*Essentials of Infant Feeding for Physicians* was received by its readers and reviewers seemed to justify the inference made by Dr. Jeans in the FOREWORD that it would “supply specific needs.” Because almost all of the stock of the first book is exhausted, the question of preparing another edition arose. Since 1952 there have been at least four new texts published covering the subject of infant nutrition, and there have been new editions of standard text books on pediatrics all with revised sections on the infant dietary. It was concluded by the author and publisher in this book to emphasize and amplify those sections of the first text which proved so acceptable and helpful. Also for this reason the title of the book was changed to reiterate the essential sections which seemed important and popular in the first venture.

The chapter on the bottle-fed infant milk foods has been completely re-written, and the classification of all of the products has been revised so as to make it more understandable and useful. All of that which presently seemed superfluous in the first text has been deleted, and each chapter has been reviewed and changed for better orientation and usefulness, with the condensing of some chapters and the elimination of others. The controversy as to solid food additives of the first year has been completely revised with the hope of a better understanding as to the

varied opinions and conflicting recommendations of a group of nutrition authorities versus those of clinicians. The subject of breast feeding and human milk has been appraised as to modern concepts, and the sections on formula computation and vitamin additives have been improved and extended. A chapter on practical everyday problems of office practice in infant feeding has been added to assist those whose clinical experience in infant feeding might be enhanced. These, then, are the changes and additions which have been made to the first book, rather than a corrected version to the first printing, or specifically a new edition.

The author is especially indebted to his colleagues in the institutions with which he is associated; to the many practicing physicians in other sections of the country for aid in relating their experiences; to the infant food manufacturers for their generous cooperation involving much correspondence; to Dr. John L. Reichert, the author's office associate of many years for his considerate interest; to Miss Charlotte Drew, Mr. William Hamilton and associates, and Dr. W. O. Robertson for supplying many of the references in the literature; to Professor Ann Schwab of Trinity University, for suggestions as to grammatic construction and rhetoric composition in certain areas; to Dr. E. H. Parfitt and the organization with which he is associated, for helping to make possible some of the special projects which contributed valuable additions to the feeding data here presented; and finally, to Mr. Robert Schinneer, Mr. Warren Green and Mr. Payne E. L. Thomas of the Charles C Thomas organization, for their specific and combined assistance, cooperation, patience and courtesy in our contacts during this mutual venture.

H.F.M.

*Chicago, Illinois*



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## INFANT FOODS AND FEEDING PRACTICE



## Chapter One

### AN ORIENTATION

**A**N EMINENT investigator and authority on infant nutrition, the late Dr. Philip Jeans, stated that there exists a lag of 15 to 20 years between the time that scientific truths are discovered in the nutrition laboratory and the time that they are accepted and utilized by the practicing physician. It is hoped that this text will help to bridge this gap in a shorter time so that the physician may avail himself of these truths involved in the newer knowledge of nutrition as they are applied to infant feeding.

The physician in general practice, according to a study made by the American Academy of Pediatrics, attends the needs of 60% or more of American children. He is faced with the minor problems of normal infant feeding routines, and it would serve him well to be adept at the simple facts and expediences inherent in practical infant feeding. The new pediatrician embarking on his practice will be amazed and perhaps somewhat disillusioned to learn that 60 to 80% of *his* practice will consist of regularly scheduled physical examinations of *normal* infants, as well as directing the feeding care of these *well* babies. His special knowledge and diagnostic skills in dealing with abnormal gastroenterology, such as fibro-cystic disease of the pancreas, megacolon, diabetes, electrolyte disturbances due to the many types of gastroenteritis, and the anomalies of the gastrointestinal tract of the newborn infant—all of these will be *unusual* experiences on which to practice his special training and knowledge. Unless he is successful in directing the needs of the well infant with the minor intolerances to foods or to varied food demands, he may not be the physician in charge to make the specific diagnosis of the exotic and unusual.

### THE TEACHING OF INFANT FEEDING

The observation has been made by some who have in their care the teaching of medical students, and who might be described

(as did Dr. A. A. Weech in another setting (21)) as "enjoying the blessings of scholarly objectivity while being protected from the pressures of private practice," that the subject of infant feeding is elementary and simple indeed. Their premise would be merely to expose the students to a general course of bio-chemistry and nutrition in the curriculum, and thus the problems of practice in infant feeding would be easily understood. Those who deal daily with the homely and practical phases of practice of this subject are keenly aware that *applying* the principles of nutrition chemistry is a far cry from everyday infant feeding problems. The medical student, intern, and even the resident after three years of specialized training in pediatrics, find it perplexing to translate their academic and hospital preparation to the practical problems of clinical infant feeding in the welter of factual and pseudo-scientific data beamed upon them.

In a questionnaire survey of 88 of the 90 four-year medical schools in the United States and Canada, the following salient data were elicited pertaining to infant feeding instruction: (108)

1. 91% of the schools include instruction in infant feeding in the required *formal* (lecture) didactic course in general pediatrics, usually in the III medical school year.
  - a) Of this instruction, 66% spend 1-2 hrs. per week in this year on the normal infant, and 88% on the abnormal feeding states.
2. 46% of the schools devote time to *informal* infant feeding teaching (clerkships and ward rounds).
  - (a) 45% of this informal teaching deals with well infants and 67% with abnormal feeding difficulties.
3. Numerically few have facilities for, or instruct students by means of, well-baby clinics.

As may be seen from these abstracted data, little time is spent indoctrinating medical students in a phase of their training which will be an important part of their work with infants if they embark in either general practice or in the specialty of pediatrics. As far as can be discerned from the survey and from experience in talking to residents in pediatrics from many medical schools, this part-of-one-year exposure to infant feeding practices is apparently the sum of their training in infant nutrition. Few hos-

pitals-approved-for-residency-training in pediatrics have any further formal or informal instruction in well-baby feeding other than can be acquired by the resident himself, usually dependent on his own initiative. Little wonder then, that the medical student matured to the practicing physician, relies heavily upon journal advertising and mail-brochure promotion for his working and practical knowledge in a field which he could easily master with his scientific training and background.

It is hoped that this text, containing the essential principles and descriptions of available products for infant feeding may help to alleviate these deficiencies of the medical school curricula and of the varied hospital training programs.

### HISTORICAL SETTING OF INFANT FEEDING

Since the beginning of Man's struggle for existence, the pre-eminent need for an adequate food for his suckling young was probably second only to *self*-preservation. From archeological discoveries, by frequent allusions in the records of Man's writings and inscriptions, and from the interpretation of his art forms from the beginning of prehistoric time—from these sources we know that Man's quest included this search for adequate nutrition for his young.

#### Earlier Endeavors

Infant feeding with other than human milk as an art or science is a matter of recent times. Only in the last five or six decades can one even speak of a *science* of infant feeding. Among the Ancients, anything other than breast feeding in this sense was unknown if we may judge by the records handed down to us. In vain does one look for a reference to the subject in Hippocrates, Galen or the Arabians, or from any other ancient physicians or philosophers. Only crudely empiric efforts were made throughout the Middle Ages and, even up to less than a century ago, led to futile and even grim results with young and older infants (18).

The earliest attempts at substitute feeding consisted in making the goal of all effort that of adapting the milk of a foreign species to the human infant. Many different mammals were used for this purpose, including the goat, ass, camel, llama, caribou, dog, horse, reindeer, water buffalo, sheep and, of course, universally the

cow. (See Table 8.) The feeding of the infant was arranged either by direct nursing from the udder by the baby, or by indirect feeding from a vessel after the milk had been drawn. The use of such milks is still basic and forms the starting point of nearly all bottle feeding.

The results that followed the use of unaltered whole milk from any mammal were so disastrous that dilution with water naturally followed as a simple method of making milk "weaker" and more acceptable to the infant gastrointestinal tract. Later, sugar and other carbohydrates were added to equalize the loss in caloric content due to dilution, a principle which is still fundamental. The advent of bacteriology, a newer knowledge of the chemical and physical behavior of human and other milk, the discovery of vitamins and their significance in nutrition—all were further milestones of great importance in the evolution of modern infant feeding.

### **Recent Achievements**

The modern epoch of scientific infant feeding began some 60 years ago with Biedert in Germany and Rotch in this country. Steadily increasing progress has been made since that time, and in the last three or four decades it has been placed on a scientific basis as firmly as any other branch of medicine. As happens in such widely diversified endeavors by many outstanding investigators of the time, there was an ever-increasing confusion of ideas, theories and practices, which in retrospect seems almost ludicrous in the light of present knowledge. We no longer evolve infant feeding formulas with slide rules and higher mathematics. Today we have emerged from a "chaos of complexity" into what we might call a "chaos of simplicity" (18). We are actually confronted in any given case by the question of which simple method of feeding to choose from in a large and constantly increasing assortment that all lead to the same result, differing only in substance rather than in principle.

Mention must be made of the final chapter in this devious and interesting history of infant feeding. It was Drs. Joseph Brenne-  
mann and McKim Marriott of this country who set the stage for the finale in this drama of confusion. Beginning with Brenne-

mann's observations in 1910 on the curd of cow's milk in vivo, pragmatism was created out of chemical disorder. Utilizing all the information available on the digestion of casein in the infant stomach, he contributed toward clarifying the perplexity which reigned between the various feuding schools of thought. After similar observations had been made on curd formation by Marriott, in which he extolled the importance of the *hydrogen ion* in the gastric digestion of casein, the main obstacles in the chemistry and physiology of infant feeding appeared to have been determined.

An air of finality seems to have been cast on this controversy by the Council on Foods of the American Medical Association, which adjudicated this minor dispute in a report (35), part of which is here quoted: "Brennemann, who as a result of his former experiments interpreted the value of acid milks in terms of curd texture, undertook a crucial experiment to evaluate the role of the acid. . . . [He] was forced to the conclusion that curd texture, and not acidity, is of prime importance and that the value of acid milks lies in the modification of the curd. This conclusion has been amply supported by the work of Lyness, and of Jeans and Stearns."

### Systems of Infant Feeding

In résumé, four methods in the recent history of infant feeding can be enumerated, all of which are basic to our present state of knowledge, and vestiges of which still persist in modern practice and thought.

1. Feeding Undiluted Whole Cows' Milk. This viewpoint has had little vogue in recent years, but was the constant and empiric method in practice in France, England, and sporadically in Germany for a long time. Since raw whole cows' milk was originally intended for the herbivorous offspring of a cow, the human infant's stomach except in a minor percentage of babies, was not able to tolerate milk in this state. Changes were made arbitrarily, such as adding sodium citrate to the milk or boiling it, either of which made it more, but not completely, acceptable.

2. Percentage Feeding. It was found empirically in the final decade of the last century that certain proportions of milk, cream, lime-water, water, and milk sugar seemed to agree better with

the average baby. The percentage composition that seemed most universally acceptable was: fat, 3.5%; protein, 1.2%; sugar, 6.6%; minerals, 0.25%. When this formula (cream, 1½ oz.; milk, 1 oz.; water, 5 oz.; milksugar, 3⅜ oz.; lime water, ½ oz.) was found not to suit all babies, the principle was laid down that if this combination did not suffice, by trial and error the percentages of these constituents were to be changed to fit the infants' needs. When this failed, the above basic formula was to be offered in a weak mixture of all the components and then gradually increased to what seemed the desirable amount.

It further became necessary to devise methods for calculating what amounts of the different ingredients of known composition were required to give the desired percentages of each food element, and conversely, to reduce the percentages of any given formula. This difficult procedure required almost the equivalent of an advanced degree in higher mathematics, employing algebraic equations to compute the food mixture for a baby. This led to the establishment of the Walker-Gordon Laboratories in the larger cities over the country. Here, by means of slide rules and arithmetical gymnastics, these laboratories supplied the computed formulae on data submitted to them by the physician. The practitioner readily got the impression that this subject was too complex to apply to practice, and he soon left it for the simple, patented food mixture, or for some simple milk dilution with a well-advertised carbohydrate added.

3. *Single Formula Mixtures.* Partly as an outgrowth of the complexity of the *Percentage Feeding*, as well as the constant search over more than 50 years for the one combination most nearly resembling human milk, the one-modification milk method has held sway, and even has its proponents at the present time. *Whey Reduced* and *Whey Adapted Milks*, with emphasis on the mineral components, began this period, and *Synthetic Milk Adapted* (present day "SMA") was one of the variables which resulted from this evolution. (See page 107.)

The search for a single formula food has always seemed alluring, and at least defines sharply the requirements and limitations of substitute milk feeding. Like the quest of the biologist of history and fiction who strove for the creation of life from combinations of inanimate organic compounds, so the search for the crea-

tion of human milk from cows' milk or some combination of chemical components to do this—still goes on. It seems that some biological intangible in human milk still separates the chemist and theorizing nutritionist from realizing this dream. Many One-Formula Mixtures, with the advancement of our knowledge of nutrition have come near the solution. Certainly they are adequate for most infants but are still limited in their flexibility but not in nutritional standards. There are examples of this class extant at the present day (Tables 19 and 20) and represent this interesting phase in the history of substitute milk feedings.

4. Simple Milk Dilution With Addition of a Carbohydrate. The final phase which represents the present status or tendency of the evolution of infant feeding is incorporated in this category. It represents the oldest and most extensively employed method of milk modification down to the present time. It differs from the percentage viewpoint in its greater simplicity, dealing with *amounts* of milk, sugar, and diluent, rather than *percentages* of the different food elements. It forms the basis of the most rational, and at the same time, the simplest method of procedure.

In the main, by this method the fat, protein, and minerals are reduced by dilution as is the sugar. The latter element, at the level of 7%, found in the baby's natural food—human milk, must be added back to a nearer normal amount to satisfy fuel requirements. The degree of dilution necessary to make cows' milk more acceptable to infant digestion is arrived at purely empirically, varying with the state of the protein of the milk offered—whether boiled, alkalinized, or acidified. The degree of dilution of milk also depends on the arbitrary experience of the clinician. It finally depends upon the infant himself, whose progress in weight gaining, evidence of digestion, and receptiveness to the proffered combination, are the final criteria of any successful food formula.

Emphasis has been made by various exponents of the latter method of feeding, on the value of the milk in units and thus *caloric feeding* has been introduced or combined with this method (as an index of its success or failure in producing growth). This is simply the evidence that the diluted-CHO-added mixture can be calculated to provide a definite amount of energy or weight by computing the caloric values of the various constituents. It serves as an adjunct rather than a severe requirement. The aver-

age experienced physician, feeding infants from his intuitive background or "instinct," rarely pauses to compute calories. Here again the status of the infant directs his course, and he is prone to exceed rather than minimize the caloric values offered. If the infant fails to gain in the expected manner, and especially with premature infants, this computation is indicated. To compute a formula, however, with only the strict caloric requirements in mind (50 to 55 per pound of expected body weight) without noting the results or needs of the infant, illustrates again the fallacy of dogmatism.

### CONTEMPORARY HISTORICAL CONTRIBUTIONS TO THE PROGRESS OF INFANT FEEDING

Lest the chemist, the nutritionist, or the physician become bigoted in their historical views as to the factors which contributed to the rapid success of infant feeding, it is well to enumerate contemporary phenomena which occurred simultaneously with the advancement of the science of this field. These factors of progress which added so much to the achievements of infant feeding were the same which also marked the advancement of the standard of living and economic progress of the first half of the twentieth century in America. These are briefly stated:

1. The advancement of modern methods of canning and preserving of food.
2. The universal use of modern plumbing and the elimination of outdoor toilets in urban and rural communities.
3. Modern home and factory screening against flies.
4. Methods of sewage disposal and other sanitary engineering advancements.
5. Development of artificial ice and its economic distribution.
6. The invention and general availability of mechanical refrigeration in the private home.
7. Pasteurization and refrigeration of milk.
8. Establishment of hygienically controlled milk sheds which supply milk to the large metropolitan areas.
9. Establishment of infant welfare stations.
10. Improvement of transportation and the roads upon which this is facilitated.

11. The acceptance and execution of solid food additives to the first year dietary, albeit overdone from a strictly nutrition viewpoint.
12. The consuming interests and executive skills by leaders in the public health field.
13. The development of a hygienic consciousness, begun early in our educational system and carried to all age levels through reading, health columns and special feature articles in newspapers and magazines to all strata of our modern society.

Each of these factors contributed its intrinsic part to the integration of the forces which produced the marked advancement in infant feeding successes as we know them today. These factors also contributed to the marked decrease of infant mortality during the first year (160 per 1,000 live births in 1880 to 24 in 1957) in the past 80 years (127).

#### ARBITRARY GLOSSARY OF CONTROVERSIAL TERMS

An explanation is made here of certain terms of common usage in the field of practical infant feeding which seems justifiable for the reasons stated below. No one is more impressed with the vagaries of recondite terminology than when authorship of a text is assumed. There are many who are modernists in grammatical usage of language yet see fit to split fine shades of meaning of certain definitive terms. Since there is no *Bergen Evans Dictionary of Contemporary American Usage* to lend authority to the following specific terminology, the author will assume that arbitrary position guided by opinion expressed in scientific literature, by the rudiments of etymology, and with the use of large portions of liberal judgment and common sense. No assumption is made by the author of official opinion in this field nor is any finality of definition implied.

**Breast Milk or Mother's Milk** are popular terms which are accepted freely and well-understood by common usage. The purists die hard, however, when they hear or read these expressions, and the inference is often pointedly made that one should define which of the several thousand members of the Class Mammalia is implied, since *breast feeding* and the possession of

*mammary glands* are the criteria for zoological taxonomy and are the common distinguishing features of this Class. In the light of this biological definition and requirement it would seem acceptable to dispense with these (above) non-specific terms and use the species name of **Human Milk** as a specific food, and the term of **Breast Feeding** as it applies to the technique of nurturing the human young.

**Formula**, as inferred by the fluid food ingested by the human infant, had its origin in the not-too-distant day when milk mixtures for infants were computed by higher mathematics and with the use of slide rules. An effort has been made to imply simplicity of milk food ingredients in any given prescribed combination by the use of the term **Milk Mixture**. The terms *Formula* or *Infant Milk Formulas*, once fashionable and connotating a kind of technological meaning have lost favor, with even the Latin suffix *ae* for the plural having been dispensed with in the light of a more general implication of the meaning of the prescribed liquid mixture for ingestion by infants. Thus it will be used interchangeably with the term **Milk Mixture**, and it is hoped the more esoteric readers will concur in this compromise and explanation.

**Artificial Food** or **Artificial Feeding** is strongly objected to by many quasi-etymologists interested in the field of infant feeding. They contend that there is no substance or ingredient used for infant fluid foods which is not *natural* in its origin, and that *artificial* infers an inorganic source. Here also is a term which has grown popular by usage, and implies not so much the origin of the preparation to be ingested but rather the mechanical process or device by which the infant obtains the food. To placate those who sense an un-warm or un-natural inference in the use of *artificial* for any food combination other than human milk, this concession is here made to them, and is hereby deleted from this book. Other compromise synonyms such as *ersatz*, *substitute*, or *synthetic* might be acceptable, but the all-inclusive terms **Bottle-Fed Foods** or **Bottle Feeding** as applied to infant fluid foods, when reconstituted or as presented in the commercial container, should be more acceptable. The author is grateful to Dr. E. H. Parfitt for acting as an arbiter in this dilemma and for suggesting this comprehensive term.

**Proprietary Foods**, as a definitive term for classification or otherwise, has engendered a quiet resentment with many of the manufacturers of infant foods. The contention is advanced that products so classified are comparable to *patented* preparations where the nature and quantity of the contents are secret. Nothing could be more untrue or non-factual because *only the name* of many infants foods is registered and *not the content*. Since an improper connotation may be implied of a commercial flavor and which could be made of all milks and infant foods used for infant feeding, this term *proprietary*, appearing 72 times in the antecedent book, is here graciously omitted. The term *proprietary-named* would be acceptable by definition but it is cumbersome and would not be applicable to all such infant foods because not all of the names of these products have been registered. Therefore the name **Bottle-Fed Foods** will be substituted as a fair and all-inclusive compromise. (See page 86 for explanation of the symbol ® in relation to *proprietary-named* or *proprietary-name-registered* products.)

An arbitrary but useful distinction is made by the author in the text between the terms **Infant Feeding** and **Infant Nutrition**. The more specific and practical terms of *infant feeding* is assumed to include the applied facts of the more comprehensive and research-implication of *infant nutrition*. Nowhere in the literature or in the official nutrition hierarchy are these definitions inferred as here implied, but the author by his own license of academic need draws this nebulous and theoretical distinction for practical purposes. They are otherwise and in other places used as analogous terms and have interchangeable usage.

The terms **Fresh Milk** or **Sweet Milk** are an anathema to some manufacturers of infant milk foods. These terms apparently might imply that all other milks are not *fresh* or *sweet*. In deference to this vague meaning which might be inferred, in this book the terms of **Bottled Fluid Milks** or **Dairy-distributed Milks** will be used. It is hoped that the foregoing clarification of arbitrary terminology will be acceptable to those various persons and interests who were so courteous in calling their definitive meanings to the attention of the author.

## Chapter Two

### NUTRITIONAL DATA AND ESSENTIAL REQUIREMENTS

ANY MANUAL, no matter how concise, dealing with infant foods and feeding should contain an outline of the elementary chemical and physiological principles involved in this branch of nutrition albeit controversies exist in this expanding field. There are many excellent treatises in the literature from which the following material has been taken, and the interested reader is referred to the more complete sources recorded in the bibliography.

Also in this chapter will be found tables from generally accepted authorities containing the most recent information on nutritional data. They are not included to fill up pages nor to impart a pseudo-scientific aura upon this book. They have been carefully selected from many sources and are relevant to the research which is presently current in the field of nutrition. Some have no attendant textual material or explanation but are presented for easy reference should the reader desire detailed information on a given query, while others will be referred to in other sections of the book in later pages. Much of the following material on the physiology and chemistry of digestion is taken from the text—*Infant Nutrition* by Jeans and Marriott, and is reproduced here by permission of the publishers, C. V. Mosby Co., St. Louis (89).

#### ESSENTIALS IN THE PHYSIOLOGY OF INFANT NUTRITION THE FATS

All fats consist of a combination of fatty acids and glycerine. Fat, as such, cannot be absorbed from the intestinal tract but first must be saponified, which consists in the separation of the fatty acid portion of the fat molecule from the glycerine, and this is accomplished only when the fats reach the intestinal tract. There is no fat digestion in the stomach, and the only role the fat plays

TABLE 1  
THE COMPONENT FATTY ACIDS OF HUMAN MILK AND COWS' MILK FAT  
(percentage weight) (27)

	Human Milk <i>Baldwin and Longenecker</i>	Cows' Milk <i>Hilditch and Longenecker</i>
Butyric.....	0.4	3.0
Caproic.....	0.1	1.4
Caprylic.....	0.3	1.5
Capric (decanoic).....	2.2	2.7
Lauric.....	5.5	3.7
Myristic.....	8.5	12.1
Palmitic.....	23.2	25.3
Stearic.....	6.9	9.2
Arachidic.....	1.1	1.3
Decenoic.....	0.1	0.3
Dodecanoic.....	0.1	0.4
Tetradecenoic.....	0.6	1.6
Hexadecenoic.....	3.0	4.0
Oleic.....	36.5	29.6
Octadecadienoic.....	7.8	3.6

in this organ is to delay the emptying time when present in unusual amounts.

**Duodenal Digestion.** The digestion of fats begins in the duodenum where first, emulsification occurs. The bile is slightly alkaline and contains, among other elements, the salts of the bile acids (*taurocholic and glycocholic*) which are effective in promoting the emulsification, as well as the churning action of the duodenum. The next step is saponification, which is accomplished by the enzyme, *lipase (steapsin)*, one of the component parts of the pancreatic juice added at this point. The activity of this enzyme is enhanced by the presence of bile. Through the action of the *lipase*, the emulsified fat is saponified or converted into fatty acids and glycerin, and absorbed as such.

When duodenal contents are alkaline, or when the partially digested fat reaches the lower intestine where the content is alkaline, soaps are formed by the combination of the free fatty acids and the bases which are found here. Some calcium soaps are formed, especially when the food contains much casein (*calcium caseinate*). These calcium salts are partially dissolved by the bile and absorbed, but the remainder pass normally through the intestinal tract and appear in the stools as curds (fat curds).

After the glycerine and fatty acids have passed through the intestinal wall, they form a neutral fat. The recombined fat resembles more nearly the natural fat of the individual than of food fat. Fat is not absorbed directly into the blood, but is taken up by the lymphatics and carried to the blood stream in a fine emulsion by way of the lacteals and thoracic duct.

**Abnormal Fat Digestion.** The fat of human or cows' milk under normal conditions is almost completely saponified. In the presence of diarrhea, the intestinal contents may be hurried through so rapidly that some fats escape saponification and appear in the stool as neutral fat. Also, when the flow of bile into the intestinal tract is obstructed, saponification and absorption are not complete, and large amounts of soaps and some neutral fat pass through the intestinal tract, not being utilized. In general, the capacity of infants to digest and absorb fats is more limited than for either proteins or carbohydrates. Even a slight digestive disturbance is likely to result in a diminished absorption of fat. Unabsorbed fatty acids are capable of causing gastrointestinal irritation.

When there is abundant carbohydrate and protein in the diet, little fat is burned, the major part being stored. During starvation, a large portion of the energy requirement of the body is met by the utilization of the stored fat. The amount of fat, therefore, is dependent upon the state of nutrition and the amounts of other foods fed and not merely upon the intake of the fat.

Fat is not absolutely essential in the diet, as it may be replaced by protein or carbohydrate as sources of energy. Fat has a caloric value of more than twice that of either protein or carbohydrate, and is an excellent substitute to make up the necessary caloric requirements of a given diet or formula mixture. When fat is omitted from the diet, it becomes necessary to give larger amounts of carbohydrate and protein. In both human and cows' milk, the fat provides about half of the total calories. It must be remembered that the fat of milk is the vehicle for vitamins A and D and that these must be supplied in some other form when the diet is low in fat.

An excess of fat in the diet of the bottle-fed baby should be avoided. Ordinary cows' milk contains not more than four per cent

of fat, and the dairies hold it to this amount. Top milk or cream or "high fat-content" milks are not needed in infant feeding, and the temptation to increase an infant's weight rapidly can best be done by other means, contrary to lay opinion that the shortest way to a well nourished baby is by increasing its fat intake.

In marked contrast to the accepted opinion, Holt and his associates (77) presented evidence that it may be desirable to feed high fat diets to prematurely born babies. They concluded that although such infants do not absorb and retain fat well, by increasing the fat content of the diet, the total or net amount of fat absorbed and retained was greater when more fat was supplied, although the fat percentage absorption remained the same. They indicated the possibility of increasing the caloric intake without bulk by extra fat, an important consideration in premature infants.

**Substitution of Vegetable Fats.** Vegetable fats have been shown to be more fully utilized than is cows' milk fat by the newborn, and even more so by the premature infant. Holt, *et al.* (78), have reported that while the full-term infant utilized 88.9% of butterfat and 95.1% of olive oil, premature infants utilized only 58.3% of butterfat as compared with 72.4% of olive oil. A variety of fats have been substituted for milk fat, consisting of tallow oil, soy bean oil, peanut oil, coconut oil, corn oil, cocoa butter, and various fish-liver oil concentrates to replace the normal fat of milk. This principle has been utilized in many of the commercial bottle-fed foods.

**Homogenization.** The fact that the fat globules of cows' milk are larger than those of human milk (18), as well as the fact that emulsification of the fat in the intestine occurs by churning, has led to the employment of a process known as **HOMOGENIZATION**.

TABLE 2\*  
THE REDUCTION OF CURD TENSION PRODUCED BY HOMOGENIZING  
MILKS OF DIFFERENT FAT CONTENTS

	0.02	1.0	Per Cent of Fat			
			2.0	3.0	4.0	5.0
Unhomogenized . . . . .	66	58	56	50	48	45
Homogenized . . . . .	64	31	28	21	18	16
Reduction in curd tension . . . . .	2	27	28	29	30	29

\* Based on Babcock, C. J.: *U. S. Dept. Agr. Tech. Bull. 832* (1942); Herrington (74).

By this procedure, milk is driven with great force through fine apertures, resulting in a smaller, almost dustlike globule. Theoretically, the smaller surface area of each fat globule should aid in fat digestion. Much of the fresh milk available at the present time is homogenized, as are the fats of many of the commercial bottle-fed food mixtures.

In addition to the fat globules being broken up into many smaller ones, homogenization also has effects on the physical state of the milk and subsequent digestion. These are: making casein more easily coagulated by heat; accelerating the lipase action; retarding the development of oxidized flavors; and yielding a softer curd when coagulated by rennet or pepsin (74, 78).

#### **N.R.C. DATA ON FATS**

The most recent data on Fat investigation is here summarized from the Recommendations of the National Research Council (131):

Fat is the most concentrated source of food energy, providing per unit weight more than twice the number of calories derived from proteins or carbohydrate. The unsaturated fatty acids such as linoleic and arachidonic acids are essential in the nutrition of experimental animals and possibly also for man. Food fat, in addition, serves as a carrier for other fat-soluble essential nutrients, i.e., vitamins, A, D, E, and K. Fat is stored in the body to afford energy for later use, its high caloric density and low solubility providing superior qualities for purposes of storage. The deposits of fat in adipose tissue afford insulation and protection for the body against external forces. In addition, certain tissues, such as resting muscle, utilize fatty acids as a primary source of energy.

Much attention has been given to the potential harmful effects of excessive intakes of fat, or of some kinds of fat. In the United States, with its relatively high mortality rate from coronary artery disease, and with a large proportion of food calories derived from fat, much interest has attached to findings on the subject, and broad proposals have been made for correcting the national diet. The present knowledge of fat metabolism and of the relation of dietary fat to the occurrence of disease has been recently reviewed by the Committee on Fats in Human Nutrition of the Food and Nutrition Board of the National Research Council. It

is not yet possible to state definitely a reasonable allowance for fat in the diet or to indicate the characteristics of a fatty acid mixture most favorable for the support of health. A diet selected from a wide variety of foodstuffs, both vegetable and animal, is most likely to maintain good health.

**Summary of Principles.** Here appended are the **Fundamental Principles** utilized in the manufacture of bottle-fed foods as pertaining to the Fats, which have been discussed in the preceding paragraphs:

- I. Homogenizing the fat globule.
- II. Replacing milk fat with more readily absorbable vegetable and other animal fats.
- III. Removing part of the fat of milk products (low-fat milks).

### THE PROTEINS

As has been stated, each of the main components which make up the infant's dietary has "had its day" in the field of chemical investigation. The fats, carbohydrates, and proteins each have enjoyed precedence by investigators, and each seemed most important at that time as interpreted by chemical research. The current interest is now in protein investigation.

When the physical, rather than the chemical, characteristics of the protein in the stomach were elaborated upon in the middle 1930's, the controversy and the fundamental question of infant digestion of milk seem to have been concluded. The scientific establishment of the importance of amino acids (oral and parenteral administration) has been made since 1935. Utilization of this discovery is responsible for many milk-food products emphasizing the amino acids, and their administration is generally accepted as standard procedure (See Tables 9 and 10). Much of this had been touched on by earlier investigators and was only recently re-emphasized and made more practical by the advent of protein supplements available for administration. Fundamentally, however, the importance of the curd of the protein of milk was established by Brenemann and Marriott, and seems to have settled the most confusing question of milk digestion up to that time or since. An outline of the protein chemistry of milk is here briefly presented, and its importance emphasized.

**Empiric Casein Modifiers.** It had long been noted that various

agents added empirically to cows' milk seemed to facilitate and accelerate the digestion of milk. In this later day, we know why many of these substances added to milk did aid this action. The effect is explained by the softening or preventing the formation of a hard curd of milk in the stomach of the infant. Many of these casein modifiers are still used; local customs and provincial practices are still found exemplifying others of them, as rudiments of earlier procedures in infant feeding. A list of these is here presented:

1. Lime Water, 5-10%.
2. Milk of magnesia.
3. Sodium citrate.
4. Peptonization (*could be included with No. 9*).
5. Cereal waters (barley, farina).
6. Cream mixtures.
7. Whey added for "split protein" effect.
8. Buttermilk.
9. Enzyme (*Chymogen, pepsin and rennin* added to milk).
10. Dilution with water to lessen casein curd formation.
11. Acidifying—addition of lemon juice, vinegar, orange juice; hydrochloric, citric, acetic or lactic acid.
12. Boiling.
13. Drying.
14. Evaporating.
15. Homogenizing.

That these procedures rendered a useful and necessary service cannot be doubted. All but the last 7 have fallen into disuse, because almost all milk used in infant feeding today is boiled, evaporated, dried, or acidified, by each of which the same result is attained more simply and effectively. The others remain as vestiges of procedure of that not-too-distant day when the accurate knowledge of the principle and importance of curd-softening was not known.

**Stomach Digestion of Milk Protein.** When any milk is introduced into the stomach of an infant, it is normally mixed with the enzyme of the stomach (*rennin*) and to some lesser degree with *pepsin*. This initiates digestion of the protein fraction of the milk and is enhanced by the HCl also secreted by the stomach. The

*rennin* performs its action optimally when the acid state reaches pH 3.6 in the case of human milk, and less in the case of cows' milk. Aided by the warmth of the contents and the churning action of the stomach, digestion continues, which consists of the separation of the curd from the whey.

The initial digestive effort of raw or unchanged cows' milk results in the tough curd of casein (calcium caseinate) which is 85% of the total digestive result. The liquid whey (lactalbumin) is the

TABLE 3  
RATIO OF COMPONENTS IN GASTRIC DIGESTION OF MILK (18)

	Lactalbumin (Whey)	Casein (Calcium Caseinate)
Cows' Milk .....	15%	85%
Human Milk .....	60%	40%

remaining 15% of the digested residue. In human milk the lactalbumin fraction is 60% of the result of gastric digestion and the remaining casein is only 40%, the latter in the state of soft, flocculent curds. The accepted theory until recently has been that lactalbumin is the more valuable of the two proteins because it is more nearly the composition of body protein. Casein is deficient in certain amino acids and hence larger amounts of lactalbumin must be fed in order to provide the same amount of body protein. Human milk contains less protein than does cows' milk, but 60% is lactalbumin compared with 15% in cows' milk. For this reason it has been assumed that bottle-fed infants require more protein than breast-fed infants. However casein and lactalbumin now have been shown by various investigators to be equally effective in maintaining nitrogen balance, which leaves us to find some other explanation or excuse for feeding babies larger amounts of cow's milk protein than we do human milk protein.

When it has reached the proper acidity, the whey portion passes almost immediately through the pylorus into the small intestine, and the remaining casein is gradually broken down over a period of time (three hours or more with raw whole cows' milk, two hours or less with human or evaporated milk) and small curds and some whey protein enter the duodenum. Small amounts of both casein and lactalbumin are converted into albuminoses and peptones,

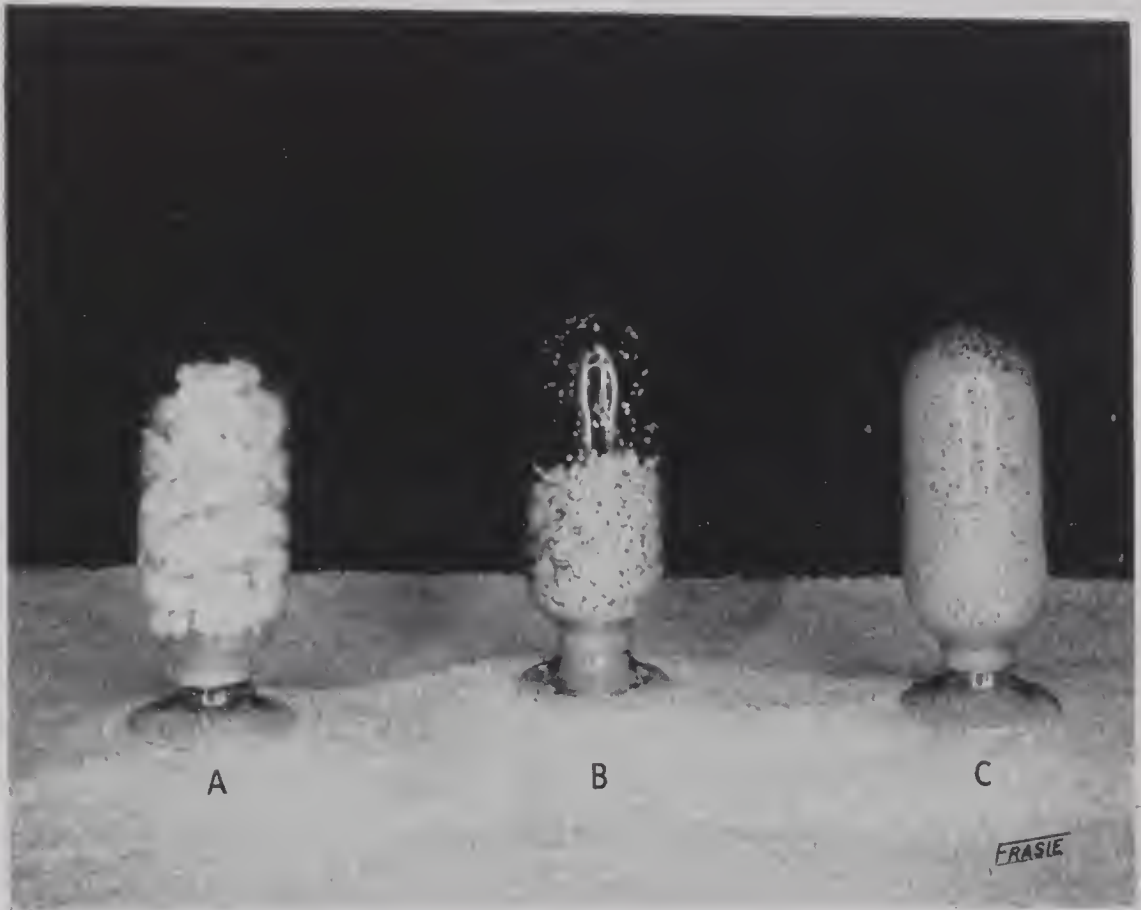


Fig. 1. Curds of whole raw cows' milk after one hour of conditions simulating normal stomach digestion. A. Hard leather-like curds, 2-2.5 cm. in length, of raw milk; B. Smaller curds 0.5 cm. showing the effect of dilution with water; C. Small sand-like curds after boiling raw milk for three minutes.

but the greater part of the digestion of protein is completed in the small intestine.\*

**Curd Tension.** Since the state of the protein presented for digestion in the infant stomach was the last of the important principles of infant feeding to be clarified, it is logical that some method should be devised whereby this important index of digestibility be measured and determined. To say that a curd of one milk is less tough, or smaller in size in the infant stomach, is not

\* It has been observed in the bio-chemistry literature since 1951 that the terms *proteoses*, *albuminosis*, and *peptones* have been discontinued. There has been no official pronouncement as to this deletion but it is assumed that they are incomplete and obsolete terms without accurate chemical definition. *Peptides* and *polypeptides* are fractions of protein breakdown which can be defined and continue to be used in the literature.

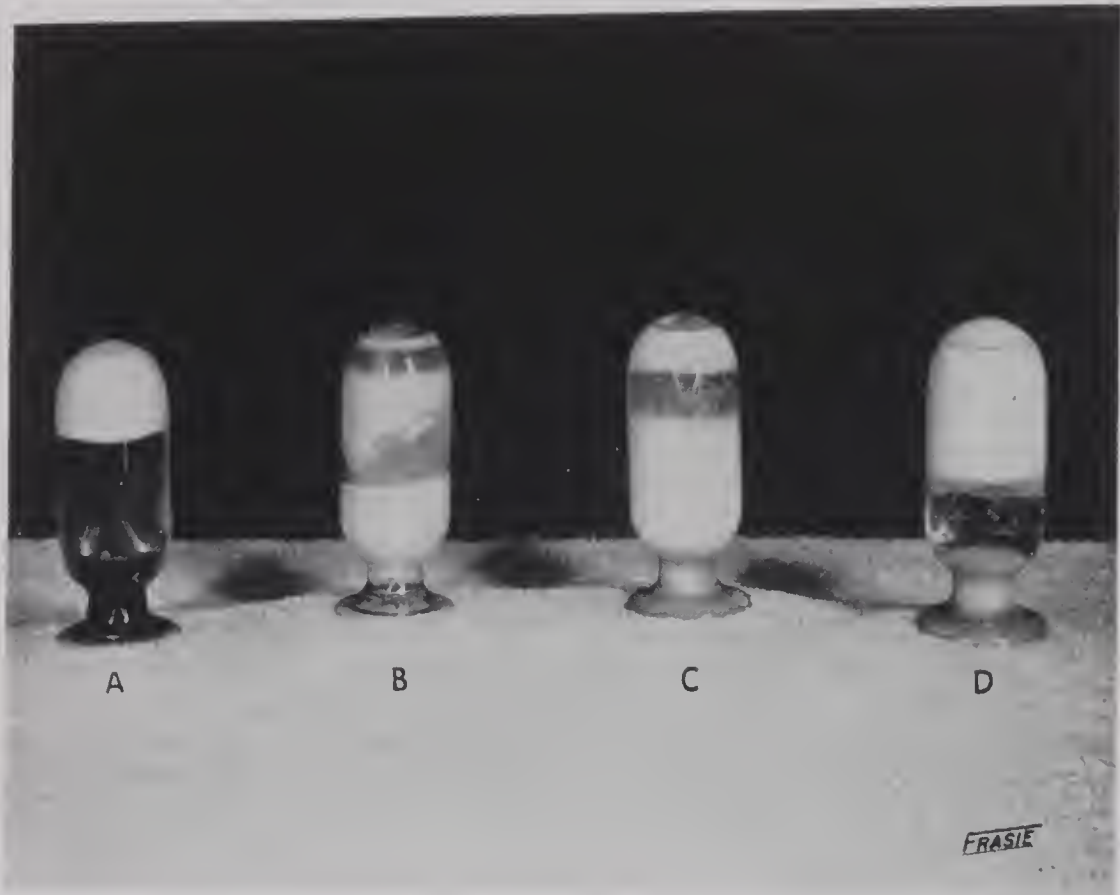


Fig. 2. Various milks after one hour of digestion. A. Soft flocculent curds of human milk; B. Soft curds of whole milk with the addition of lactic acid; C. Fine curds of a pre-modified milk. D. Loose, fine, flocculent curds of any evaporated milk, with texture of human milk.

definite enough for adequate comparison. To be able to state in some quantitative term how one milk varies from another in this characteristic would be another standard of rating milks, since curd tension is related to digestion. Many ingenious and interesting technics have been devised to study the tensile strength of the calcium caseinate curd *in vitro*.

The description of the methods devised for the determination of curd tension may be found in the papers listed in the bibliography where the interested reader may avail himself of the varied and original procedures which have been employed. Stated briefly, any method consists of coagulating the milk in a vessel by a solution of rennin (and usually calcium chloride), and the force required to pull or push a horizontal knife blade through this curd is read on a spring balance. The curd tension thus is measured in

terms of grams of force under standard conditions, and the curd tension is expressed in number of grams. The technics of Hill; Spur and Wolman (164); Cole; Miller; Doan and associates (49); all vary in degree toward a more absolute and constant procedure. Chambers and Wolman (26) utilized latex bags suspended in a water bath and imparted a wave-like motion to the bags and contents alike to simulate the peristaltic contractions of the stomach. A final report of a committee appointed by the American Dairy Science Association in 1941 was an effort to standardize a prescribed method to facilitate constancy in results (30). Differences in coagulant, in size and design of knife used, etc., account for the conflicting reports in the curd tension indices of various milks. The

TABLE 4  
TYPICAL VALUES FOR THE CURD TENSION OF VARIOUS MILKS (74)

	Grams
Cows' milk.....	46
The same milk plus an equal volume of water.....	20
Reconstituted spray-dried milk.....	10
Reconstituted roll-dried milk.....	5
Evaporated milk.....	3
Human milk.....	1

above outlined technic is usually followed for uniformity and comparison of values.

The standardizing committee referred to states the following as to the importance of these values: "Curd tension values are not considered an absolute index of digestibility for infant feeding purposes. These values do correlate in a general way this property, and the determinations (of curd tension) appear to be the best available and simplest methods for the purpose."

The ideal score or perfect state of any milk as to its curd tension is "0" (zero). Satisfactory curd tension inferring best digestion is any milk having less than 20 grams, although some investigators allow an upper limit of 33 grams. In Chapter 5 there is found the listing of milks in which the curd tension has been established. It is presumed that in the future, more manufacturers of various bottle-fed milks may qualify the curd tension value of their product, as some do at present. This will provide still another criterion for the evaluation of bottle-fed milk foods.

**Duodenal Digestion of Milk Protein.** In the duodenum, the

enzyme *trypsin*, another contribution of the pancreatic juice, is added and further digestion continues. Here the protein residue from the stomach is fractionated, producing simpler proteins, peptones, polypeptids, and amino acids. (See footnote on page 22) There is also secreted by the duodenal glands a proteolytic enzyme, *erepsin*, which further breaks down these remnants of the protein molecule which have escaped tryptic digestion to the amino acid stage, in which state the protein is absorbed under normal conditions.

**Large Intestine Action on Milk Protein.** The large intestine secretes an alkaline juice, but no enzymes. Any digestion that occurs here is merely a continuation of the processes of the residue that has previously escaped digestion and absorption. Very little absorption of food materials occurs in the large bowel, and under normal conditions, more water is absorbed in the large than in the small intestine. Bacterial activity is usually vigorous and may result in the decomposition of protein remnants because of a putrefactive flora. Some commercial bottle-fed foods are designed to change this flora to a more fermentative one which is said to be more normal. (See pages 66 and 104.)

**Protein Requirements.** Protein is essential for the maintenance of life and for the building up of body tissue. The protein need of the infant is proportionately greater than that of the adult because of more rapid growth of the infant organism.

When protein of high nutritional value is fed, the minimum amount upon which adequate growth can be insured is about 1.5 grams per K of body weight per day. An excess of protein above this minimum requirement is distinctly desirable. The average breast-fed infant receives about 2.5 grams per K per day and this may be considered optimum. The protein of cows' milk has a lesser nutritional value and hence, the bottle-fed baby should receive more than his fellow breast-fed contemporary. An adequate amount would be from 3 to 4 grams per K per day. This amount is obtained when the infant receives one tenth of his body weight in cows' milk per day, which would be 1.5 ounces of cows' milk per pound of body weight (see Chapter 4 on *Formula Computation*). The expected, rather than the actual weight, is taken for this computation in underweight infants.

If the protein content of the diet is insufficient, growth and

weight gaining are slowed, the musculature becomes flabby, secondary anemia may develop and resistance to infection decreased. In severe or prolonged starvation, nutritional edema may develop.

A moderate excess of protein in the diet apparently does no harm. Jeans (89) states that the danger of excess protein in the diet may be considered practically non-existent if other dietary factors are not entirely excluded. On the other hand Holt states that there may be a maximum protein intake beyond which an infant may suffer ill effects such as kidney hypertrophy and increased water requirement (79). Foman and May (56) state that greater retentions of nitrogen by infants on greater protein intakes from cows' milk mixtures do not promote greater growth rate than breast-fed infants. There is a greater accumulation of nitrogen in infants receiving cows' milk than those on human milk and this greater retention concurrent with the same growth rate would infer an "alteration of body composition." The authors are of the opinion that until this change of body composition is known, evaluation of human milk substitutes should be based on growth rate and nitrogen retention equivalent to, but not necessarily greater, than those observed in infants receiving human milk.

In two conferences on nutrition (the World Health Organization, and the Josiah Macy, Jr. Foundation) agreement was reached that with cows' milk or human milk protein as standard, the daily protein requirement of infants should be set at 2.2–2.5 gm. per K at birth; 2.0 gm. per K at 2 months; and 1.5 gm. per K at one year. Following is the textual recommendation of the National Research Council in its latest Recommended Daily Allowances (131) which is more liberal than the above estimates (2.5–3.5 gm. per K from 2 to 6 months and 2.0–3.0 gm. per K for the rest of the first year.)

### **Protein (N.R.C.)**

Protein in the diet is necessary to afford sources of nitrogen and amino acids to be utilized in the synthesis of body proteins and other nitrogen-containing substances. The proteins of the body fulfill essential roles, contributing to tissue structure and being involved in a variety of important metabolic functions. Some 22 amino acids have been determined to be physiologically important. Of these, eight have been demonstrated to be re-

quired from food sources in the adult diet, since they are not synthesized in adequate quantity by the body. This group of *essential* amino acids includes isoleucine, leucine, lysine, methionine, phenylalanine, threonine, tryptophan, and valine, and it is probable that dietary sources of a ninth essential amino acid, histidine, are necessary to maintain growth during childhood. The diet must therefore afford sources of the essential amino acids and sufficient other nonessential amino acids so that nitrogen equilibrium may be maintained. Certain of the essential amino acids are important not only in protein synthesis but in other physiologic roles as well. Tryptophan, for instance, is a precursor of niacin, and methionine functions as a methyl donor.

Protein allowances for normal adults have been made on the basis of one gram per day for each kilogram of desirable weight. This has been a long-established figure based on investigations of nitrogen balance and includes a reasonable margin of safety to meet added demands of individual variation in protein requirement and the difference in nutritive quality of proteins derived from different food sources. The allowance assumes a diet adequate in content of calories and other essential nutrients.

Recognizing that these procedures are tentative, that the allowance of 1 gram per kilogram is not excessive in relation to that commonly consumed in the United States, and that the question of reserve needs remains unanswered, the Board retains its recommendation of 1 gram of protein per kilogram of body weight for normal healthy adults.

In regard to protein needs during pregnancy, it has been demonstrated that the growth of the fetus and adnexa in pregnancy causes a significant increase in protein requirements above those of nonpregnancy. Although manifest throughout, the greatest demands for additional proteins are during the latter half of pregnancy. The recommendation is that 20 grams daily be added to the basal allowance of one gram of protein per kilogram of body weight for the last five lunar months of pregnancy. This allowance provides for variation in dietary protein quality.

During the period of lactation, protein is required in added amounts to meet the needs of milk production. It is proposed that this need be met by a supplement of 40 grams daily in the diet of the lactating woman.

For infants, human milk is the desired source of nutrients. Breast feeding is particularly indicated during the first month of

life when infants show handicaps in homeostasis due to different rates of maturation of digestive, excretory, and endocrine functions. Protein needs in early infancy are fully met by mother's milk when infants are fed at the breast and the process of lactation in the mother is not limited. For this first period, therefore, breast feeding should be encouraged as the desired and best procedure for meeting nutrient requirements. Although there is variation in protein content of mature breast milk, the average concentration is about 1.2 grams of protein per 100 milliliters. Usual quantities consumed by nursing infants afford an intake of about 2.5 to 1.5 grams of protein per kilogram body weight during the first six months of life. The dietary allowances to meet these needs are therefore afforded the mother. These are taken into account as additional allowances for the woman during lactation, and are included in the Table of Recommended Dietary Allowances. (See Table 31.)

At the termination of breast feeding the infant must be transferred to other food sources, the most important of which is usually cow's milk, or formulas containing it as a chief constituent. Other infants may of necessity have to be adapted to this type of feeding at an earlier date because of an inadequate supply of milk from the mother, or for other reasons. The observations concerning protein utilization in infants fed cow's milk are extensive but permit only approximation of requirements. Criteria which have been utilized in determining protein allowances for infants include metabolic studies, gain in weight and body length, and reaction to stress as measures of health.

When supplemented diets containing cow's milk in amounts of 600 to 1000 milliliters per day (average protein intake 3.2-4.3 gm/kg) are fed over long periods of time, there is nitrogen retention and good growth performance as determined by gains in body length and weight and clinical appraisal of the infants. Studies of nitrogen retention and growth performance of infants fed cow's milk formulas providing lower levels of protein intake are few in number and results too variable to permit use for determination of specific allowances.

The protein in human milk represents about 8 per cent of the total calories. Available evidence does not permit conclusions as to whether there is or is not a significant difference in the biologic value of the proteins in human milk and cow's milk. Levels of intake of 3.5 grams per kilogram from age 1 month to 6

months, and of 3.0 grams per kilogram during the remainder of the first year, are undoubtedly well in excess of minimum requirements and afford ample allowances to meet the needs of healthy infants. Allowances for the artificially fed infant may lie in the range of 2.5 to 3.5 grams per kilogram from 2 to 6 months, and 2.0 to 3.0 grams per kilogram during the remainder of the first year. In current practice, diets furnishing 3.5 grams of protein and more per kilogram are in common use.

No change is made in the protein allowances for preschool, school, and adolescent children. These estimates were originally made from nitrogen balance studies as found in the literature on the protein intakes of thriving American children with relatively free access to common foods. Whether the observed intakes in the U.S. above the recommended dietary allowances are desirable is unknown, but there is no evidence that they are harmful.

**Current Problems in Protein-Amino Acid Ratios.** Every physician interested in adult or infant nutrition must be aware from the medical and "trade" literature that much attention is being directed toward investigation of the protein-containing essential amino acids and their relative importance. There is presently a controversy extant among the leaders in the field of infant nutrition as to the relative values of some of these indispensable amino acids, and little agreement can be found from the reports of the investigations, particularly those of Albanese, and of Holt. In some of the commercial literature, preparations are extolled which contain specific essential amino acids, particularly that of *lysine* as a severe supplementary requirement. As so often occurs, when there is a new ramification in nutrition investigation, there are those manufacturers who exploit the newer findings as critical—in their efforts to extoll this quasi-need in their particular products.

The author of this book is in no position to act as arbiter in this controversy. The best policy is to accept the opinions of those who have the training, wide experience and wisdom to evaluate the various claims. Dr. Frank E. Rice, from a long background in the nutrition field and who has a large acquaintance with the literature in this area has an extensive review on the published material on protein and amino acid requirements of the infant.

The interested reader in this ever-changing scene is urged to consult this review and summary for a better orientation. (197) (198)

Some of these observations are here quoted directly: "The average infant formula prepared from cow's milk provides protein and the essential amino acids in about the quantities and ratios required by an infant for maximum growth, with a reasonable margin to spare."

"Whether there is a need to supplement infant-feeding formulas with *lysine* is controversial. The data show that the intake of this amino acid from a milk formula is well above even the highest requirement figure that has been published."

"Human milk of average composition appears to supply protein and amino acids at levels no more than marginal."

"The amino acid pattern of the cow's milk-protein-mixture compares favorably with that of human milk-protein, and with the infant-requirements pattern for the various indispensable amino acids."

"There is no indication that under the usual formula-feeding routine the baby is receiving too high a level of protein."

**Allergenic Proteins of Milk.** Normally, proteins are completely broken down into amino acids before absorption as such from the intestinal tract. In certain individuals, this mechanism appears to be disturbed and they may absorb incompletely digested proteins directly into the blood stream sufficient to sensitize that infant to further absorption of that particular protein. This is one explanation of the allergenic state developed against milk protein. The lactalbumin fraction of cows' milk is said to contain the allergenic factors to which infants are sensitized. For this reason, many of the commercial bottle-fed foods have been developed which provide proteins from other sources and which are said to obviate or reduce this possibility. (See pages 93-122 for further discussion.)

**Summary of Principles.** In summarizing the essential facts which may be gleaned from the discussion of the chemistry of the proteins, the following *Fundamental Principles* are listed as those employed in the manufacture of bottle-fed foods, involving the chemical data pertaining to proteins from the preceding paragraphs:

I. Modifying the calcium caseinate curd by: boiling, evapo-

rating, drying, homogenizing, enzyme digestion, acid, alkali, or cereal water addition.

- II. Replacing or changing the protein fraction (lactalbumin or casein) due to allergenicity of the intact protein (accomplished by hydrolysis of the intact protein; by substitution of vegetable for animal protein or by changing to protein of another mammal).
- III. Reducing protein to simple states (peptides and amino acids) by enzymic hydrolysis to permit parenteral or oral nutrition.
- IV. Increasing protein percentage—addition of a purified protein (as calcium caseinate).

### THE CARBOHYDRATES

The carbohydrate factor of an infant's dietary requirements, found normally in milk, has enjoyed more attention from nutrition investigators in the history of infant feeding than any other nutrition unit. There have been veritable waves of chemical investigation and emphasis on the carbohydrates, with more credence placed upon them at times than is justified in the face of later chemical and clinical experience.

Cows' milk is diluted essentially to lessen the fat component of the milk. It is accepted generally that even normal fat in milk (3.5%) is poorly tolerated. The casein curd is more flocculent in the infant stomach when whole milk has been diluted, and thus remains one of the fundamental aids in the digestion of milk. The CHO of the milk is also diluted inadvertently and hence should be added back to the original amount (4.5%) or more to furnish additional calories for optimal weight gain. Added CHO also is ascribed the following accepted roles: permits normal metabolism of fat; allows protein to be used to build new tissues rather than to provide calories; encourages normal water balance. (See also page 146 and references (32) (126) (23) (40).) For these reasons the CHO looms up for an important consideration. There are many commercially prepared and natural sugars available for modifying cows' milk, emphasizing the importance that the CHO plays in the prescribing and manufacture of food mixtures.

Carbohydrates are chemically simpler substances than the pro-

TABLE 5  
SCHEMA OF CARBOHYDRATE REDUCTION

(Polysaccharides)		(Disaccharides)		
Starches	Dextrins	Lactose	Sucrose	Maltose
↓	↓	↓	↓	↓
Dextrins	Maltose	Dextrose	Dextrose	Dextrose
↓	↓	Galactose	Levulose	Dextrose
Maltose	Dextrose			Dextrose
↓				Dextrose
Dextrose				Dextrose

(Dextrose is least readily fermented because of rapid absorption.

Levulose and galactose are most easily fermented because less readily absorbed. The conversion of dextrins to maltose is slow, leaving only a small amount of fermentable carbohydrate available at any time. Because of this virtue, the dextrins make up a large per cent of most of the commercial CHO modifiers.)

teins, and are made up of carbon, hydrogen, and oxygen in simple chemical structures. The most complex of the CHO is starch, the next most complex are the dextrins, after which come the disaccharides and then the monosaccharides respectively, in the last state of which they are absorbed. Stated schematically in Table 5 is the simple process by which sugars are reduced—either by acid hydrolysis or diastase action in vitro, or by the action of the enzyme *amylase* in vivo.

From Table 5, it may be seen that all CHO digestion ends ultimately in the monosaccharide. Only in the simplest form (monosaccharides) can sugar be absorbed. If sucrose or lactose are introduced into the blood stream by injection, they are not utilized, but excreted unchanged. Maltose may be partially utilized as such, but this has no practical significance.

**Salivary and Gastric Digestion.** Salivary digestion of CHO in the infant is of little import until the act of chewing starchy foods is begun. The saliva has no effect on milk but when starch is fed (cereal waters as diluents of the formula, or cereals in the bottle, or by spoon) some of the enzyme *ptyalin* is added to the starch in the mouth and this digestion continues for a short time in the stomach. CHO is not acted upon by the gastric juice, except for a slight conversion of disaccharides to monosaccharides by the acid of the stomach.

**Intestinal Digestion.** The sugars enter the intestine before the fats and proteins. The monosaccharides arriving in the intestine

are promptly absorbed as such under normal conditions, while the disaccharides are broken down by the enzymes secreted by the small intestine to their respective monosaccharides.

The main digestion of the starch (higher sugar molecule) occurs in the small intestine by the enzyme *amylase*, one of the constituents of the pancreatic juice. The same process transpires as presented in the schema—the starches to dextrins to disaccharides to monosaccharides—takes place in an orderly fashion. This absorption is almost completely executed in the small intestine.

If the digestion and absorption of the small intestine is impaired, or if too high a percentage of sugar is fed, fermentation of the CHO by bacteria with the production of organic acids occurs. These acids may irritate the intestinal mucosa, and in the presence of gas as the other by-product of fermentation, both may lead to impaired absorption of all food elements as well as dysfunction and distress of varying degrees in the infant. This event may occur in the small intestine, or some sugar may reach the large bowel, and here the fermentative action takes place with the subsequent symptoms of loose, foamy stools, excessive flatus and distention.

**Fate of Absorbed CHO.** The blood sugar level remains between 0.1 per cent during fasting, and 0.15 per cent during the height of CHO digestion. At about 0.17 per cent, some dextrose begins to pass into the urine. The mechanisms which keep the blood sugar between these limits, are well regulated. The dextrose which is needed for fuel is burned in the tissues, while the remainder is stored in the liver and muscles in the form of glycogen, or converted into fat and stored in different parts of the body. During starvation the stored glycogen is converted back into dextrose and utilized through the blood. Some dextrose becomes available through the metabolism of protein, up to 60 per cent of protein being convertible into dextrose. Conversely, the administration of adequate amounts of CHO spares body protein during states of underfeeding or starvation. The change of carbohydrate into fat for storage is another fate of the ingested CHO. The necessity of adequate CHO administration is demonstrated in the section on *The Fats*.

### Recent Data on Carbohydrates (Summarized by National Research Council (131))

Carbohydrates and fat represent the most important sources of food energy. Together they account for approximately 90 per cent of the calories in the national diet in the United States. It should be appreciated, however, that in the body there is ready interconversion of carbohydrate, protein, and fat long physiologic pathways of metabolism. The food energy in the simpler carbohydrates such as sugars and starches is readily utilized by the body. More complex carbohydrates such as cellulose, hemicellulose, and lignin are not wholly digestible and apparently function to provide bulk for the intestinal contents. Evidence is not available to provide a basis for establishing a recommended allowance for carbohydrate.

**Principles Utilized in CHO Modifiers.** A detailed description of the various carbohydrates available for modifying infant food milk mixtures is found in Chapter 6. The many adaptations commercially of the principles outlined in the section here under discussion will be amplified there. The essential facts which contribute to CHO metabolism should be remembered from this section of this chapter to understand better the many products which are found in the field today.

The following are the *Fundamental Principles* obtaining in the manufacture of commercial carbohydrate and milk modifiers which involve the chemistry of carbohydrates reviewed in the preceding paragraphs:

- I. Addition of a larger proportion of dextrans to reduce fermentation.
- II. Increasing the per cent of maltose or lactose to produce more fermentation.
- III. Substitution of extraneous carbohydrates (fruit sugars) which seem to be more easily tolerated, such as banana and pectin-fructose combinations; agents as Pectin-Agar-Dextri-Maltose®, which are said to coat the intestinal mucosa in gastroenteritis.
- IV. Utilizing the observed fact that normal enzymatic action must occur, releasing absorbable monosaccharides more slowly in the infant bowel.

- V. Using non-cereal starches to avoid allergenic grain sources; removing allergenic proteins appearing with the starch molecule.
- VI. Using starches of grains (barley, wheat, oats, corn, tapioca, rice) which, because of their colloidal state, effect a more finely divided curd when combined with the casein in the stomach.

### WATER AND MINERAL CONSTITUENTS

Since this book deals with the infant under normal feeding conditions, only the facts pertaining to water and mineral metabolism of the *well* infant will be considered here. Much has been added to our scope of knowledge in the laboratory by way of the infant in the metabolic chamber, all of which is valuable to the ultimate understanding of the baby's normal and pathologic states. It is not within the premise of this text to relate all of these data in detail. From time to time, metabolic investigation has led into this sphere, and we are at present in one of these periods where the interest in electrolytes holds sway. Since this interest is concerned mostly with abnormal states of the infant metabolism, the subject is too complex to be considered with oral feeding. The following sections will include generalizations as pertaining to the water and mineral requirements of the well infant.

**Water Requirements.** The average, normal, breast-fed baby under six months receives about  $2\frac{1}{4}$  ounces of water daily per pound of body weight in the milk ingested, which amount is sufficient for the needs of most infants with some to spare except during hot weather, during febrile states, and in the presence of body fluid loss as in diarrhea and vomiting. Because the protein and mineral content of the bottle-fed baby's diet is higher, there is an increased output of salts and nitrogenous material by the kidneys which requires in turn a larger fluid intake. This extra amount is minimal for all practical purposes so that the bottle-fed infant need not have a larger fluid intake than his breast-fed contemporary. It is not essential that the total fluid intake be in the feeding mixture alone. Any infant may be offered water from a bottle, spoon, or cup between feedings to supplement his pos-

sible needs. (See Darrow *et al.* regarding water requirements in heat stress (40).)

An excess of oral fluid intake over computed needs is not likely to produce any disturbance. Great dilution of food "to make the formula weaker" is not within the realm of intelligent formula construction. The capacity of an infant's stomach is limited, and dilution merely initiates another problem of inadequate calorie intake. Formulas may be concentrated to surprising degrees without any reaction on the part of the baby. In the presence of normal digestion in small infants, the mixture is intentionally concentrated so the effort and time of ingestion may be shortened.

Some babies may take a surprising quantity of water, not because of a physiological need, but because of inadequate food. Others drink water readily to exploit the sucking reflex, in which case it is merely another form of a pacifier. Mothers are informed in the lay literature directed toward them that a baby must take "two ounces of water twice per day," and strenuous efforts are made to carry out this dictum. It is the author's experience that most infants who consume large amounts of water are not getting enough food, and should have their hunger satisfied. It may be said categorically that without the use of arbitrary standards—in normal and well infants—the fluid requirement is satisfied if the baby is offered water at convenient times. No one adjudicates the fluid intake of the colt or calf. Instinct in water requirement is equally developed in the young of the human species, however "underdone" he may be in other respects to his mammalian contemporaries of a lower order.

**Mineral Needs.** Tables of the body requirements for minerals, as well as the amounts of those minerals found in human, cow, and goat's milk are listed in Table 6 in detail. All of these requirements of which calcium, phosphorus and iron are the essential ones, are adequately met if the baby takes  $2\frac{1}{2}$  ounces of human milk per day per pound of body weight, or  $1\frac{1}{2}$  to 2 ounces of cow's milk per pound per day. The possible exception to this is iron after the fourth or fifth month, when that stored in the liver has been exhausted. In present-day feeding routine, infants have this deficit supplemented with egg yolk, certain vegetables, fruits, commercial fortified cereal foods, and meat supplements—all of which

COMPARATIVE DATA PERTINENT TO INFANT NUTRITION  
Relative Components in Mammalian Milks Used  
in Infant Feeding (Tables 6-10)

TABLE 6  
APPROXIMATE PERCENTAGE COMPONENTS OF HUMAN MILK, COWS' MILK, AND GOATS' MILK

Type of Milk	Fat	CHO	Total protein	Lactalbumin	Casein	Ash	Calcium	Magnesium	Potassium	Sodium	Phosphorus	Sulfur	Chloride	Iron	Copper
Human . . . .	3.5	7.5	1.24	0.75	0.50	0.25	0.034	0.005	0.048	0.011	0.015	0.0035	0.036	0.0001	0.00003
Cow . . . . .	3.5	4.7	3.4	0.50	3.0	0.75	0.122	0.013	0.154	0.06	0.09	0.116	0.116	0.00004	0.00002
Goat . . . . .	4.0	4.5	3.5	0.43	2.32	0.93	0.128	0.017	0.17	0.08	0.112	0.12	0.15	0.00002	0.00002

*Data on Human and Cows' Milk*—*Infant Nutrition*; P. C. Jeans and W. M. Marriott, C. V. Mosby Company, St. Louis, Missouri, 1947 (89).  
*Data on Goats' Milk*—in part from Dr. E. L. Foreman, Special Milk Products Company, personal communication; in part from *Department of Agriculture Technical Bulletin #671* (62).

TABLE 7  
VARIATIONS OF HUMAN MILK DURING LACTATION (113)  
(Values in gm/%)

	Fat	CHO	Protein	Ash
Colostrum . . . . .	2.83	7.59	2.25	0.31
Transitional Milk . . . . .	4.39	7.79	1.56	0.24
Mature Milk . . . . .	3.26	7.50	1.15	0.21
Late Milk . . . . .	3.16	7.47	1.07	0.20

are now part of the routine feeding of almost every infant before the fourth month. Iodine is also not adequately present in the above mentioned amounts of human or cows' milk, but supplementation is indicated only in geographic regions where goiter is prevalent.

It may be said that although human and cows' milk contain

TABLE 8\*  
COMPARISON OF MILKS OF VARIOUS MAMMALS (gm/%)

Maminal	Period for Doubling Birth Weight (Days)	Protein	Fat	CHO	Ash	Calcium	Phos- phorus
Human being . . . . .	180	1.6	3.6	7.0	0.2	0.033	0.047
Horse . . . . .	60	2.0			0.4	0.124	0.131
Cow . . . . .	47	3.5	3.4	3.8	0.7	0.160	0.197
Goat . . . . .	22	3.7	4.3	4.0	0.8	0.197	0.284
Sheep . . . . .	15	4.9	5.0	4.6	0.8	0.245	0.293
Pig . . . . .	14	5.2	6.8	5.0	0.8	0.249	0.308
Cat . . . . .	9.5	7.0	3.3	4.9	1.0		
Dog . . . . .	9	7.44	8.1	4.0	1.3	0.454	
Rabbit . . . . .	6	10.4	10.5	2.0	2.5	0.891	0.997
Donkey . . . . .		1.8	1.4	6.4	0.7		
Reindeer . . . . .		1.9	19.0	2.6	1.4		
Elephant . . . . .		3.1	19.6	8.8	0.6		
Camel . . . . .		3.5	3.0	5.2	0.7		
Whale . . . . .		9.5	19.6	9.2	1.2		
Porpoise . . . . .		11.2	45.8	1.2	0.7		
Dolphin . . . . .			43.7				
Rat . . . . .		11.7	14.7	2.8	1.5		
Monkey . . . . .		2.0	3.9	5.8	0.2		
Llama . . . . .		3.9	3.1	5.6	0.8		
Silver Fox . . . . .			5.4	5.1	0.8		
Hippopotamus . . . . .			4.5	4.4	0.1		

\* This table is a composite one, the values being taken from several sources: P. C. Jeans; *Infant Nutrition*, C. V. Mosby, St. Louis, 1947; B. L. Herrington; *Milk and Milk Processing*, McGraw-Hill, New York, 1948; L. F. Meyer and E. Nassau; *Infant Nutrition*, Charles C Thomas, Publisher, Springfield, 1955.

TABLE 9  
COMPARISON OF AMINO ACID CONTENT OF COWS' MILK AND  
AVERAGE HUMAN MILK (mg. per 100 cc.) (27)

Amino Acid	Human Milk	Cows' Milk
Tyrosine.....	45	184
Alanine.....	20	80
Glycine.....	0	11
Proline.....	56	252
Glutamic.....	150	744
Aspartic.....	62	192
Serine.....	43	164
Cystine.....	20	135
Arginine*	37	137
Phenylalanine*	47	191
Leucine*	128	542
Isoleucine*	47	184
Histidine*	17	68
Lysine*	54	226
Threonine*	38	167
Methionine*	18	109
Tryptophane*	17	52
Valine*	41	189

\* Essential amino acids.

ample quantities of calcium and phosphorus, without vitamin D both of these are poorly absorbed. If any calcium or phosphorus deficiency is countered by supplementing the diet, no additional absorption, utilization, or retention is observed unless adequate vitamin D (400 units daily) is also added. The assumed need for the additions of minerals (excluding iron) to many of the bottle-fed foods is seriously questioned in the light of the adequacy of

TABLE 10  
AMINO ACIDS OF COWS' MILK IN PERCENTAGES OF TOTAL PROTEIN (113)

Essential Amino acids	% of Protein	Non-essential Amino acids	% of Protein
Lysine.....	6.0	Glycine.....	0.5
Tryptophane.....	2.2	Alanine.....	1.9
Histidine.....	2.5	Aspartic acid.....	1.8
Phenylalanine.....	3.9	Serine.....	0.5
Leucine.....	9.7	Glutamic acid.....	20.0
Isoleucine.....	1.4	Hydroglutamic acid.....	1.0
Methionine.....	0.4	Proline.....	8.0
Valine.....	7.9	Hydroxyproline.....	0.3
Arginine.....	4.0	Cystine.....	0.4
	± 40.0	Tyrosine.....	6.0
			± 50.0

these in milk. The needs of the premature infant are, of course, excepted. (See Chapter 9 for requirements of specific nutrients and essential elements.)

In the composite Table 8, several interesting biological facts may be observed. The first 9 mammals are listed in progressive ratio as to the number of days required for doubling their respective post-natal weights. The amounts of protein and ash vary considerably but these are not accidental differences. They are the expression of a general biological principle that the greater the intensity of growth of a species the higher the protein content of the milk. A similar dependency on the speed of growth may be shown also in the amounts of minerals contained in the milk. These, with the calcium and phosphorus, are also essential for the formation of new tissue rapidly, and are next to the protein in importance for this function. It may also be noted, as Herrington points out, that the fat content varies from 2 to 40 per cent which is in keeping with the observation that animals living in colder climates or in water would need a milk higher in energy value which would be found essentially in the fat.

The milks of these and other mammals have long been employed as a substitute for human milk and reflect the race or civilization extant at the time of their use. However, we are reminded of Brennemann's oft-quoted truism "The milk of every mammal is specific for its young, and man is no exception." Curiously, asses' milk (donkey) in particular was extensively used since it approaches human milk more closely except in fat, is still procurable in London and is used unmodified in special instances for feeding sick infants.

*There is a principle which is a bar against all information, which is proof against all argument, and which cannot fail to keep a man in everlasting ignorance. This principle is—contempt prior to examination.*

HERBERT SPENCER

## *Chapter Three*

### HUMAN MILK AND BREAST FEEDING

THE COMPOUND heading of this chapter implies that *human milk* and *breast feeding* are to be regarded here as separate entities for more adequate discussion and understanding (see page 11 on terminology). This is due to the fact that we find ourselves in the strange paradox of extolling breast feeding as a practice while simultaneously doubts are raised concerning human milk as the "perfect nutrient." Another anomolous situation is that although there has been an over-all decrease in breast feeding in the last decade, yet in the higher family economic and educational levels of our country the acceptance of breast feeding is apparently on the increase.

#### HISTORICAL BACKGROUND FOR BREAST FEEDING

From the earliest records of man, the need for breast feeding of his young has been pre-eminent in the struggle of man with his environment. In paintings, sculpture, literature, music and other art forms, nursing of infants has been held as a high virtue. The stimulus of this artistic expression was probably expedience, since this mode of nurture stood between the attrition or perpetuation of a tribe, race or even species. Its need was known to all of the rovers and conquerors along the Mare Nostrum who held high the value of a captured slave who was a potential wet nurse. There is Gibbon's grim reminder that he places prominently on the list of causes of the fall of the Roman Empire the early dissolution of that civilization when the nursing of the young become unfashionable. Through song and story, each generation of mothers and mothers-to-be has been exhorted to breast-feed their progeny, and in both lay and medical literature the modern mothers are reminded that this ancient practice is still an important requirement of successful motherhood. And yet in the presence of modern progress on emotional lines we have evidence that in the last

ten years the art of breast feeding on exit from hospital level has decreased from 38% to 21% (109).

### EXTENT OF BREAST FEEDING IN OTHER COUNTRIES

There are many regional reports in the literature since 1945 as to the incidence of breast feeding in foreign countries (86), more infants being breast-fed because of economic reasons or perhaps because of cultural patterns. In Sweden 92.6% of infants were breast fed on discharge from the hospital; 48% to 60% of women in Norway completely nursed their infants for 9 months; 95.2% of half million babies in Germany was an average extent; 55% to 85% were breast feeding in the British Isles at one month and in a more recent study from hospital returns in all of England and Wales 85% of 350,000 infants were breast-fed on hospital discharge; in New Zealand 43% of babies were still breast-fed at 6 months; in Mexico 92% of urban and 98% of rural infants; and of 1,189 infants in Puerto Rico 64.5% were reported breast-fed. These data stand out in contrast to the over-all picture in the United States.

### BREAST FEEDING IN THE UNITED STATES

The only study which included all sections of this country at relatively the same time was done by Bain in 1946 and 1947 (9). From Dr. Bain's observations it was found that for the United States as a whole,  $\frac{1}{3}$  of the infants were on bottle feeding and  $\frac{2}{3}$  were getting mixed feedings (bottle and breast) on discharge from their respective maternity wards. Striking regional differences were noted—61% of infants were bottle-fed in the northeast in contrast to 18% in the southwest and southeast.

In 1956, another survey (109) was conducted in the hospitals of all of the states and these data were compared with those of 1946 at the exit from hospital level (see Table 11). In all of the geographic regions and in all of the states save one (Idaho), there were more infants leaving the hospital maternity nurseries with bottle feeding than there were ten years ago. As will be noted from the table, 38% of babies left the hospital on breast feeding while one decade later this per cent was 21.

The findings compared in these surveys can not be said to be

TABLE 11 (109)

PER CENT OF INFANTS RECEIVING SPECIFIED FEEDING AT TIME OF DISCHARGE FROM HOSPITALS IN 1946 AND 1956 (BY GEOGRAPHIC REGIONS)

	Breast Only		Breast and Bottle		Bottle Only	
	1946	1956	1946	1956	1946	1956
United States	38	21	27	16	35	63
Regions:						
Northeast . . . . .	23	12	16	9	61	79
East and Central . . . . .	36	20	30	15	34	65
Southeast . . . . .	55	27	27	16	18	57
Southwest . . . . .	47	27	35	23	18	50
Mountain and Plains . . . . .	44	26	28	17	28	57
Pacific . . . . .	31	25	29	19	40	56

a *trend*. Only if confirmed by similar studies in 10 or 20 years from now can it be said that a true trend exists. The results however, are reflections of important changes in our cultural pattern and are essential anthropologically as a record of the status of one phase of child rearing in this country.

#### POSSIBLE REASONS FOR DECLINE IN BREAST FEEDING

Every clinician has been exposed to the varied objections offered by mothers to breast-feed their infants. The Committee on Maternal and Child Feeding of the National Research Council (170) has listed these reasons as common objections, and are here presented as classical examples heard by every physician who deals with this problem.

"The whole idea is disgusting to some mothers whose natural feelings have been deeply distorted. Other reasons advanced are that the mother must work for her living, she will lose her beautiful figure, she gets so nervous, she will get too fat, her husband objects, she is ashamed to nurse her baby before her other children, sucking is unbearably painful or she does not want to be tied down to a routine. . . . Obviously the time to correct such attitudes is not during the lying-in period but before the baby is born."

The only statistical evidence which might contribute as a reason for the decline in breast feeding shown in the 1956 survey (109) would be that more than  $\frac{3}{4}$  (84%) of the mothers and infants

left the hospital on or before the fifth post-natal day, just when or before maternal lactation is being established. The exposure of the new mother to the exigencies of her home and its problems when she is already unstable, is often sufficient to inhibit breast feeding. Hill (75) and others interested in the factors influencing breast feeding fear this is an important reason why more mothers have little success with breast feeding in the modern day compared to 10 or 25 years ago when the post-natal hospital period was 8 days or longer.

### BREAST FEEDING SUCCESS IN MATERNITY NURSERIES VERSUS PERSONNEL ATTITUDE

It is evident by example and precept that interest of personnel at the maternity ward level is in direct ratio to the success of mothers' success at breast feeding. Cheerful encouragement and direction by the maternity nursing staff, and followed into the home by a sympathetic physician would result in 4 out of 5 or more mothers completely nursing their babies. This has been amply demonstrated at the Grace-New Haven Rooming-In project; by Waller's hospital efforts in England; by Richardson in North Carolina and Roberts in Georgia; by Kimball in Evanston, Illinois and by many other unsung proponents of this ancient art. Clement Smith, while chief of pediatrics at Bellevue Hospital in New York City was able to observe the rise and fall of breast feeding incidence in the various nursery services as reflecting the interests in breast feeding when the services alternated supervision. A dedication of imbuing mothers with the desire to nurse their infants by nurses and physicians nationwide, could easily reverse the statistical implication of the aforementioned 1956 survey.

### HUMAN MILK VERSUS BREAST FEEDING

With the advancement of chemistry, bacteriology and physiology, as well as with the increase of many accoutrements incident to the modern standard of living, other substitutes for human milk were found which were nutritionally as adequate and more constantly available. We now find ourselves in the paradoxical situation of extolling *breast feeding* as a practice, while

others raise doubts concerning *human milk* as the "perfect nutrient." In a symposium on "Milk in Relation to Human Nutrition," (80) a few of the questions raised were as follows: Do antibodies transmitted in human milk withstand digestion and enter the infant's blood stream? What of the variability of some of the constituents in human milk, such as the ratio of the various amino acids, the assortment of unsaturated fatty acids, and the over-all concentration of minerals? What are the specific virtues of the disaccharide *lactose* in human milk as opposed to other sugars used in infant feeding? Is the small proportion of casein and the larger ratio of lactalbumin found in human milk an advantage over the reverse situation found in milk from other mammals? What of the well-known lack of the specific nutrients (vitamins D and C) in this so-called perfect food? Holt (80) expressed the opinion that he did not disparage human milk, and that by and large it was an excellent food, but it was not to be worshipped as the perfect food—"the fact that a substance is found in breast milk does not constitute proof that it is a nutrient." He also added that our knowledge as to the requirements of human nutrition is far from complete and is still a challenge for more cautious and careful investigation.

The protagonists of breast feeding from a cultural viewpoint are of the opinion that many of the problems originating from the exigencies of our present social order can be best met by prevention. This program, they infer, should begin at birth. Rooming-in, emphasis on breast feeding, later use of self-demand feeding and a less authoritative attitude toward infants and children are all fundamental precepts in neutralizing some of the tensions of modern society. Breast feeding, if carried on willingly by the mother, adds to the security of the infant and contributes satisfaction as well as a sense of "being needed" to the mother. The names of Richardson, Sedgwick, Waller, Clement Smith, the Newtons, Aldrich, Spoek, Edith Jackson, Kimball, Montgomery, Bartheimer and the proponents identified with the Cornelian Corner—all these are associated with the dogma of breast feeding and have patiently extolled its inherent values and rich rewards which are attributes in promoting an ideal family environment for a satisfactory and happy infant culture.

## AMERICAN "CLASS" DIFFERENCES IN BREAST FEEDING

Despite the over-all statistieal decrease in the extent of breast feeding in the United States in the last 10 years, a strange paradox is taking place within the social order of the American scene. Where in some countries breast feeding is embraced as an economic urgency because of the lack of or expense of substitute milk mixtures, in the United States the unfortunate economic groups and lower educational levels of society nurse their infants less frequently than their more fortunate contemporaries.

Filer and Robertson (54) in an evenly distributed sample of 1,275 mothers, by the survey method, found that the incidence of breast feeding (24.4%) was about the same as the 1956 survey *loc. cit.*, and the geographic distribution was also comparable; that urban and rural extent was equal; that college educated mothers had the highest incidence of breast feeding, and that those with the highest income were more frequent in breast feeding than those in the two lower income groups.

Yankauer *et al.* (191) in the personal interview method with 1,433 mothers in New York State found among other health practices in child-bearing and child-rearing that  $\frac{1}{4}$  of the mothers attempted to breast-feed. By the class scale of the Warner Index of Social Characteristics it was observed that breast feeding was most popular in mothers of the highest (Social Classes I and II) and was continued longest. It was least popular and discontinued soonest by mothers of Class V, educationally and economically the least fortunate.

Sears and others in an investigation into patterns of child rearing (152) interviewed 379 mothers in two suburbs of a large metropolitan area of New England. Twenty-two per cent had finished college and 14 per cent had not finished high school, and according to the Warner scale of occupational status the group was evenly distributed economically. About  $\frac{2}{3}$  (39%) were breast-fed, 12% for one month or less and 12% to 3 months. The authors presumed to be disturbed at the 26% who gave as the reason for not nursing as being "physically unable," and they sagely observe that the alleged inability may have been an underlying dislike for doing so.

The editors of the *Journal of Public Health* recently sum-

marized the subject of breast feeding and social classes (52). They quote a report by the Harvard School of Public Health dealing with 114 primiparous women who attended the Family Health Clinic in Boston between 1950 and 1956. In the results it was observed that the most important factors related to a higher percentage of breast feeding were college education of the parents and higher social class. Decision to breast feed was also favorably influenced by a previous experience with child care on the part of the mother. In the 3rd and 4th decade of this century there were two studies quoted in which the lower classes more frequently nursed their infants than the middle or upper class, but recently there may have been a reversal of behavior so that more middle and upper-class mothers breast-feed their infants while the lower class mothers use bottle feeding. The question is raised in the editorial as to whether child-rearing practices of mothers in different social classes have changed over in a decade or two. If it is true that there has been a revival of interest in breast feeding among the middle and upper classes and a decline in the lower class, it may represent a kind of percolation hypothesis to be hoped for—new practices beginning at the top of the social pyramid and filtering down to the lower strata. (See also Jackson *et al.* regarding incidence of breast feeding in relation to personal-social and hospital maternity factors (86).)

A most unusual impetus toward the movement of breast feeding has originated and is flourishing in a suburban community of Chicago. A group of young parents have formed The La Leche League made of small units or cells which meet in each others homes to discuss the simple facets of a "way of mothering." Any newcomers in the suburb are invited to attend the informal monthly meetings for a discussion of the simple precepts pertaining to the naturalness of motherhood and mainly that of breast feeding. They operate on a small budget, have a manual which is given to each new member of the group and there are circulated monthly letters discussing the activities of the group with feature articles on the subject of breast feeding. According to the Warner Scale these families would fit into Class II or the higher middle class both in economic and educational bases. Such a movement has infinite potentialities and could easily be the pattern for other similar groups in other areas of the country.

### SUMMARY OF CULTURAL IMPLICATIONS

The weight of evidence is still heavily in favor of breast feeding from a nutritional or from a cultural premise. The "ominous" data in the 1956 survey can be construed as a challenge rather than a complacently-accepted trend. As Dr. Herbert Ratner has aptly phrased it (130): "Breast feeding has received much lip service from everyone but the baby," and it is time to implement all of the enthusiasm for the practice of this ancient art into definite channels. Richardson (139) succinctly sums up the problem at its head waters by stating: "An unsolved mystery has always been the willingness of so many physicians to abandon breast feeding without a serious effort to conserve it. In a study of some 400 titles there are as many differences of opinion, quite as ardently held, as were some of the various theories on bottle feeding for which physicians used to do battle so valiantly a generation or more ago. If physicians who deal with infants will check these various views against their own experience, and will develop individual technics just as anyone must who employs artificial feedings in the care of infants, then it can be truly said that breast feeding has fully come of age."

### THE ART AND PRACTICE OF BREAST FEEDING

**Causes of Lack of Availability of Human Milk.** It is stated that anatomically, the number of sebaceous glands per square centimeter of skin varies widely in human beings. The amount of islet tissue in the pancreas has been observed to differ normally in different individuals. The number of glomeruli in the kidney is found in wide variance in individuals of the same age and in kidneys of the same weight, and neuroanatomists agree that there is a wide divergence in the amount of gray cortex of the cerebrum in human beings. Histologically, it also has been observed that in individual breasts there is a varied quantitative amount of stroma, tubules, and of the alveoli whose lining epithelium secrete milk during lactation.

It would seem obvious then, that different females of the human species would vary considerably functionally if there is this difference anatomically. This could account in part for the marked divergence that exists in the ability of mothers to nurse their in-

infants. This anatomical difference is subject to genetics, as are other variations in inheritance. Nowhere is this more evident than in animal husbandry, where strains of cows are inbred or outbred as to the ability to secrete milk as the object of the artificial selection. Eugenics will have to progress to a much more distant day before human matings can be arranged on a potential lactating function. It also has been frequently observed that the innate ability to supply adequate human milk is a characteristic apparent in certain families where grandmothers and their daughters, as well as the third generation are able to nurse successfully their respective children. Wet nursing in former years was also looked upon as a skill, or almost a vocation, for the women of several generations of one family.

The second and more important factor which prevents many mothers from the act of nursing their infants is due to the well-known effect of psychological inhibition on physiological function, known currently as *psychosomatic* factors. Attitudes, worry, tension and emotional instability have long been known to inhibit secretory glands from maximum efficiency. The many modern studies in physiology and psychiatry confirm this important fact. Present-day mothers are subject to many tensions and environmental components which their grandmothers never experienced. The advent of the metropolitan existence with its social demands, interference with stable living, and the disruption of that sociological unit known as *the family*—all contribute to undermine the placid life compatible with satisfactory lactation. The radio newscaster, telling in graphic language the happenings anywhere on both hemispheres, inadvertently inhibits mothers' milk supplies. The sincere hope is born that the Cornelian Corner group—who pledge themselves to "the relief of (modern) cultural tensions"—will be able to neutralize some of these detriments to successful breast nursing.

Borrowing again from the realm of the dairy herd, it is a well-known fact that certain members of that herd will decrease in amount and fat content of the milk expected if a new stable hand is in attendance, or if a strange dog is found to excite the cows by his presence. If a "bovine personality" of a cow is so affected, how then is it impossible for a human nervous system not to react

similarly when exposed to the exigencies of modern life? It is a matter of common experience to have a mother supplying four or six ounces of milk to her baby while ensconced in the comforts of a modern hospital and enjoying the freedom from cares of her everyday life, to lose within a week all of this production when exposed to the responsibilities of her home, the care of her other children, the vagaries of social demands, and the good intentions of her many visiting friends. The cycle is monotonously the same: the baby begins to feel the loss of his expected food, which makes him hungry, which he demonstrates by being irritable, which in turn worries the mother—adding to her already fullsome list of problems. The inevitable occurs, and the baby loses the precious food supply.

**Mechanism of Psychic Inhibition of Lactation.** The only significant evidence that has been demonstrated of the mechanism of the inhibition on the part of the modern mother to nurse her infant comes from the suggestion which may solve, or at least explain the reason for this deficit. It has long been known that there is a difference in lactating animals between *secretion* and *ejection* of milk. The mechanism by which milk is made available is a reflex process known as LET-DOWN and has been extensively investigated in domestic animals, but few details have been known until recently as to its nature in the human species. In animals, nerves in the teat are stimulated by sucking or milking. These impulses cause the release of the *oxytocic principles* of the posterior pituitary gland which then are carried by the blood stream to the udder or breast, which causes contraction of the smooth muscle surrounding the alveoli, forcing their contents into large ducts where it is available to the young or the milking machine.

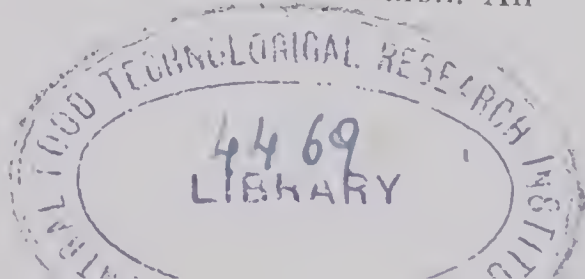
Experiments of Waller (177) and of Newton and Newton (116) demonstrate that the *let-down reflex* is operative in woman. Sucking is probably the primary stimulus which sets off the reflex, but it is conditioned to such factors as the sight of the baby, scheduled time of feeding, and breast preparations. Pain and distraction have been demonstrated to inhibit the reflex in cows and in women, and singularly enough, the inhibition may be overcome by the administration of PITOCIN, a posterior pituitary preparation

containing 10 units per cubic centimeter of *oxytocin* (Parke Davis & Co.).

In one hundred three nursing mothers studied during the post-partum period in the hospital, the existence and function of the *let-down reflex* was demonstrated. Pain, emotional conflict, and embarrassment were shown to inhibit the *let-down reflex*. Conditioning of this reflex, such as pleasant surroundings, favorite food, and the playing of a favorite music record, all helped to make it function less erratically. Waller suggests the stroking of the nipple or manual expression before a feeding to set off the *let-down reflex*. Since sucking stimulation is the primary impetus in the *let-down reflex*, it is important that the baby be interested in sucking vigorously. By well-controlled experiments, Newton and Newton (117) demonstrated that the reflex may be inhibited centrally by pain and distractions. Application of the baby to one breast produced a great flow of milk to the other breast by means of this reflex, and *Pitocin* produced an increase in the flow similar to applying the baby to the other breast.

The practical application of this principle has finally been demonstrated by Dillon (48) in stimulating the "let down" reflex by intravenous, intramuscular or transbuccal-administered natural or synthetic *Oxytocin* or *Pitocin*. In 33 of 35 post-partum women, evidence of milk secretion was produced by permitting the pituitary hormone-containing lozenge to be dissolved in the mouth immediately before the expected feeding time. This may well be another of the dreams-come-true of investigators who long have sought for an effective galactagogue. (See page 67.)

Newton and Newton in a recent study (118) demonstrated a correlation between a positive attitude of the post-partum mother to nurse her baby and her success in achieving it. Of the mothers who expressed positive attitudes toward breast feeding, 74% had enough milk by the fifth day after delivery to make formula supplementation unnecessary, while only 26% of those who expressed negative attitudes had sufficient milk. There was also a relation between the mothers who had negative attitudes toward breast feeding and their disappointment in the sex of the child and their statement that their labors were extremely harsh. An



attitude toward breast feeding is apparently not an isolated phenomenon, but may be related to the woman's whole attitude toward children. All of which indicates a species of mother whose negative attitude toward life in general is another factor in limiting the successful breast feeding of infants.

### EFFECT OF MATERNAL DIET ON QUALITY OF HUMAN MILK

It is accepted nutritionally that there are various deleterious effects on the product of gestation when the diet of the mother is inadequate. There is insufficient evidence that the same deficient diet has any demonstrable effect on the chemical constituents of the mother's milk and hence not on the infant. The only possible result would be that of deficiency in certain vitamins and essential elements such as iron and calcium (see page 193). This does not mean that the diet of the mother should be ignored during lactation. However, the essential effects of a deficient diet would not be on the infant nor any demonstrable quantitative effect on the milk secreted by such a mother. Later pathologic effects in the maternal organism would be apparent but not in the infant, since a biological rule seems to exist for the protection of the offspring.

On every maternity ward there are standard truisms which seem to be handed down from one generation of nurses and physicians to another regarding the diet of the nursing mother relative to her respective infant. No serious effort is made to seek scientific corroboration for these loosely-quoted, pseudo-scientific stock pedantics. Chocolate candy is taboo, as are pickles, smoking, too much fruit or too little fruit and etcetera. One has the impression that such overt information, distributed pointedly to the mother-novice, will yield the candy and other gifts for the delectation of the maternity ward attendants. The day is gone when every gastric, intestinal and skin disturbance of either mother or neonate can be so easily ascribed to the specific diet of the mother or to the quality of her milk.

It has always seemed reasonable that even if the diet of the mother did not affect the *quality* of the milk, that amounts of fluids taken by the mother would have a beneficent effect on the

quantity, and hence mothers have been urged to drink "one quart more than your usual fluid habits" and other such well-known and well-meant dicta. Morrison (114) states after many experiments in both animal husbandry and with human mothers that "little or no evidence exists that the yield of human milk varies with the water intake contrary to the usual impression and teaching. There is no evidence of a diurnal rhythm." When it is considered that the excess of extra fluid a nursing mother must provide would rarely be more than 30 ounces per 24 hours (most often less), it would seem that to permit natural demands of thirst would be the criterion of her excess water needs. Since no demonstrable harm is forth-coming, the excess fluid recommendation remains as one of the harmless and handy aphorisms to the frequent query "What shall I take to make more milk?", and will remain as a satisfactory positive answer, and as a substitute to the ever-new search for a galactagogue to the inquiring and anxious new mother.

#### OTHER EFFECTS OF MOTHERS' HABITS ON HUMAN MILK

*Menstruation* has no influence on the quality or quantity of human milk. There may be a lessened supply with the resultant fretfulness on the part of the infant but no qualitative effect has been demonstrated except that due to the nervous reaction of the mother because of her possible superstition.

*Smoking* on the part of the lactating mother is not contraindicated. Amounts of nicotine in the milk increase with the number of cigarettes smoked, reaching 0.5 mg per liter for heavy smokers. Infants fed such milk thrive normally though receiving about 0.2 mg of nicotine daily. Connally (85) studied the birth weight, weight gain, incidence of vomiting and other symptoms in babies of mothers who smoked varying quantities, and in those of mothers who did not smoke at all and could find no differences. He concluded that smoking even large numbers of cigarettes has no effect on lactation. In fact the sudden suppression of smoking in mothers who are accustomed to it might emotionally disturb them so that the milk supply is lessened by stopping a habit which has brought comfort and sedation.

*Alcoholic* beverages may be partaken in moderation without

any deleterious effect on the nursing. If large quantities are consumed by the mother, alcohol may be excreted in the milk. Here again the use of alcohol is even beneficial to the mother who has become tolerant to its use and leans upon it for comfort and its calming effect. Not too many years ago beer, stout and ale were bravely imbibed even by teetotalers under the general existent impression, at that time, of their galactagogue effects.

### DRUGS EXCRETED IN HUMAN MILK

This is a field which has been surrounded by much word-of-mouth impression and only recently have scientific studies oriented the accurate thought in this matter. Although many drugs and chemical entities are detectable in human milk, the number excreted in sufficient quantity to affect the baby is indeed extremely small (85). As a rule, substances of a molecular weight under 1,000 appear to pass the secretory barrier of the breast as well as the placental barrier. In the following categories are listed those drugs which are secreted in human milk which will effect the infant, and those which do not.

**Substances Excreted Which Affect the Infant.** *Bromides* and *Iodides* may well reach sufficient concentration in the milk to produce symptoms of drowsiness and even a bromide rash in the infant (85). *Thiouracil* is probably the only substance which is found in a higher concentration in human milk than in blood or urine (101). *Lead* and *Mercury* (calomel) are found in appreciable amounts in human milk. The barbiturates, notably *Phenobarbital* pass to the infant by means of the milk from the mother and act as profound sedatives (85). The active principle of *Ergot* passes to the infant, and in an experiment of babies who took milk containing ergot (85), 90% had symptoms of ergotism. *Radioactive Iodine* has been demonstrated in milk of lactating mothers after oral administration of tracer doses of the isotope (120). Either as a diagnostic tool or as radioactive therapy, such procedures are contraindicated in lactating women who breast-feed their babies since the thyroid gland of the infant may take up enough radioactive iodine from the milk to depress seriously or ablate the functional activity of this gland in the nursing baby of that mother.

In an extensive review of the effect of maternal narcotic addic-

tion on newborn infants, Cobrinik *et al* (194) report on 39 infants who were breast-fed and the effects of nursing mothers addicted to morphine or heroin. Sudden attempts at weaning always brought on recurrences of withdrawal symptoms in the babies. The use of breast feeding was considered a satisfactory therapy in gradually lessening the need for the narcotic in the infant. They reported that one author was of the opinion that morphine appears in the human milk when the mother's dosage was "high." Another author stated that the excretion of opium derivatives in the mother's milk was open to question; and that in Sollmann's text book on pharmacology (1942 edition) the statement appears that morphine is not excreted in human milk by the mother. The authors suggested that from their review, narcotics or their active derivatives are most probably excreted in human milk, but that this may be related to the size of the mother's dosage and other factors.

**Substances Excreted Which Do Not Affect the Infant.** The substances in this category reports of which are available in the literature are demonstrable in the mothers' (human) milk but have not been known to affect the baby in any way. *Caffeine* passes through into the milk in small quantities after drinking tea or coffee with no caffeine effect; *Sulphonamides*; *Penicillin*; *Mandelic Acid*; *Sodium Salicylate*; *Hexamine*; *Quinine*; and *Hyoscyne*—all pass into the milk but have no effect on the baby. "Only minute quantities of *Morphine* reach the milk (*see previous section*) and *Codeine* and *Atropine* are not even excreted and none have any reaction on the infant." (85) There is some disagreement as to whether *purgatives* may affect the baby through the milk, although it has been held that those of the anthracene group: *Emodin*, the active principle of *Rhubarb*, *Senna*, *Cascara* and *Aloes* all have been said to have some effect but is stoutly denied by others (85). *Dilantin*® has been administered to mothers without excretion in the milk and no effect to the infant (85).

No medicines can be given to the mother for the purpose of treating the child via the breast-feeding route because of concentrations of the drugs in the milk is not sufficiently high and constant (85). No drug or food taken by the mother will cause the infant to have constipation, and it is doubted whether the inges-

tion of large amount of fruit by the mother will make the stools loose, but these experimental truths will be refuted clinically by those who have not had control studies to prove their stand.

Certain organisms may be excreted in the milk despite the idea that human milk obtained from the human mother's breast is sterile. *Staphylococci* are often found in the milk of mothers free from any obvious infection but there is no evidence that they do the infant any harm (85). Most infants receive with their mothers' milk homologous antibodies of various types during the first few months of life but there is no evidence that would indicate that human milk contains sufficient antibody to protect a newborn infant from specific diseases like poliomyelitis (175).

Infants with evidence of hemolytic disease such as *erythroblastosis fetalis* may be nursed with safety. Although it has been shown that Rh agglutinins in the milk of mothers who have anti-Rh agglutinins in their blood serum (85), the infants may be nursed with impunity because the antibodies in the milk diminish rapidly in the first 48 hours and may then, if present, fail to be absorbed from the gastrointestinal tract. In England, many infants with their mothers having *rhesus incompatibilities* have been nursed successfully without harm to either child or mother, even after exchange transfusions when the infant's serum has been stabilized (186).

**Summary of Materials Excreted in Human Milk.** It is urged that in the case of questionable drug excretion in any given situation that common sense should be included in arriving at a decision. It is a matter of good clinical judgment as to whether to continue nursing an infant at the breast of a mother when the morbid condition for which she is being treated requires the diligent administration of any drug. When any doubt exists it would surely be an indication for temporary weaning. Either the drug or the breast feeding should be discontinued, whichever is deemed more necessary at the time.

## GENERALIZATIONS PERTAINING TO BREAST FEEDING

**Contraindications to Breast Feeding.** The absolute contraindications to nursing have not changed in recent years. These are: complete absence of milk—a rare but obvious reason; intractably

inverted nipples; tuberculosis; and any constitutional or debilitating disease which threatens the immediate health of the mother.

In the relative contraindications, such as anemia, nephritis, heart disease, pneumonia, epilepsy, badly fissured or painful nipples, one is swayed one way or the other by the mother's actual condition rather than by the baby.

It is accepted by authorities that when a mother has a distinct aversion toward the act of feeding her infant based on a preformed opinion or attitude, the post-partum period is not the time to dislodge these deep-seated concepts. If she does not yield to gentle urging, if she does not respond to logical dispersion of her fixation, or will not even agree *to try* to nurse the baby, then attributes which accrue to the mother and baby in breast feeding are dissipated and it would be best to accede to the mother's wish, hoping that with another infant later she can be better indoctrinated.

In response to the mother who has the firm desire to nurse her infant and after a trial period in the hospital and home it still is impossible for some physical or psychological reason, it was found necessary to editorialize for the benefit of these mothers. In the proper setting such mothers develop a degree of frustration bordering on a minor psychosis thinking they are not meant for parenthood and other extreme variations of inadequacy. For this group it was found expedient to offer some solace, which is best summed up by the Survey of the Committee on Maternal and Child Health of the National Research Council (170) headed by the authoritative names of Aldrich and Macy:

"As a food, human milk still remains the best type of milk for young infants, although it is probably not always a complete food after the first few weeks. Breast milk has definite preventive and therapeutic value. It is economical, automatically produced, and time saving in the household. . . . As a technic, breast feeding probably is the best method of providing gratification and a sense of security to babies. However, even when she is using artificial feeding, the loving mother can impart an adequate amount of that security in her manner of handling the infant. Breast feeding is a maturation point in the sequence of maternal development, which is important physiologically and psychologically to mothers. Concrete proof of the psychological value of breast feeding as a technic is badly needed. An insufficient sup-

ply of breast milk requires complementary feeding if persistent efforts do not increase the supply. Minor objections to breast feeding arising from faulty antepartum attitudes, mistaken ideas and failure to appreciate the emotional value of nursing in child care can best be met in the prenatal clinic. They cannot be handled as adequately after the baby is born."

**Temporary Weaning.** Temporary weaning during mastitis, acute infectious diseases, the common cold, sore throat, or fever of undetermined origin usually can be carried out by expressing the milk and discarding it until the acute disability is over. Unfortunately, this often becomes a permanent weaning because of the failure of emptying the breasts artificially, or the debilitating effect of the disease on the mother, together with the nervous state engendered in her.

**When to Begin Initial Breast Feeding.** The time to initiate breast feeding has been variously standardized by hospital routine and pediatric dogma. It would seem reasonable that it would depend on the severity of the ordeal through which both the mother and infant have just passed, and hence is largely an individual matter. After the mother has had a good rest or sleep for six to 10 hours would be a reasonable time to try the baby at the breast for the first effort, to help the mother establish her emotional status toward the baby and to test out his sucking ability. It is an observed fact that an appreciable amount of milk sufficient to nourish the infant is not obtained until the third to fifth day. The earlier efforts, therefore, would be merely to initiate the sucking reflex, to harden the nipples of the mother to the task, to utilize the colostrum with its manifold chemical and physiological properties, but most of all to acquaint both mother and child with each other and to begin the act of nursing with which both must become acquainted.

Other than in hard labors or unusual situations pertaining to the alertness or somnolence of either mother or child, various routines agree largely that after about 12 hours post-partum, the infant may be brought to the mother at four-hour intervals, and to continue this time interval about five times per day, with the omission of a night period unless special indications are present.

In a survey of 1,904 hospitals as to various infant feeding practices (110) it was found that the age at which infants were first offered food varied widely. As seen in Table 12 the greatest

number of infants were first put to the breast at 12 hours of age, with extremes of 4 to 36 hours. Most infants were not offered bottle feeding until 24 hours of age. Apparently the age for initial feeding was selected arbitrarily. Some nurseries were dogmatic concerning the introduction of water, tea, solutions of glucose or protein before milk mixtures were added.

TABLE 12  
AVERAGE AGE OF INFANTS (IN HOURS) WHEN FEEDING IS BEGUN (110)

Hours		Breast	Bottle	Not Specified
4	Hospitals reporting	4	0	19
	Infants included	5,198	0	17,884
8	Hospitals reporting	33	7	123
	Infants included	44,945	8,117	154,487
12	Hospitals reporting	127	21	815
	Infants included	165,859	28,235	912,422
18	Hospitals reporting	8	7	128
	Infants included	11,902	8,123	158,164
24	Hospitals reporting	19	138	589
	Infants included	31,304	184,728	696,816
36	Hospitals reporting	2	21	21
	Infants included	3,174	37,099	26,625

**Length of Time of Each Period.** The length of time of nursing is a variable and arbitrary period, depending on the nursing vigor of the baby and the amount and freedom with which the milk is received. It has been well established that 90% of the milk will be obtained in the first seven minutes of continuous nursing. In the first three days, time is not much of a factor—practice of a technic being the vital value. After this period, when the milk has “come in,” any period after seven minutes until the infant becomes somnolent would be a good “rule of the thumb” to follow. It must be borne in mind that the mother’s nipples are not accustomed to this new function and that fissured and sore nipples can be a psychological as well as a real menace to nursing, so limitation of the infant to a period of 10 to 12 minutes would be appropriate at first. The amount of milk obtained at each feeding, ascertained by “ac” and “pc” weighing after the fourth day, and not the length of time of nursing, should be the vital criterion in the physician’s judgment.

**Intervals Between and Number of Feedings.** Both factors—the intervals and number of feedings—have been subject to too

much specific dogma, and arbitrary rules have been laid down without factual data to support them. Various customs or fads have had their day, varying from a *two-, a three-, a four-hour routine* interval and back to the "*feed 'em when they cry*" standard. Obviously, from a hospital and maternal viewpoint, the four-hour interval is ideal and is one that has been adopted generally—if it is equally advantageous to the infant. There should be room left for flexibility for the infant who is lazy, sleepy, or a poor nurser. The final index, however, is again how much does the infant receive and is adequate growth being realized by the baby? The interval between feedings and the length of time of each feeding is significant only when the sum of all the 24-hour feedings is compared with the known daily requirements, as well as the infant's satisfactory weight progress. A young baby's need is about  $\frac{1}{7}$  to  $\frac{1}{6}$  of his body weight, or roughly, two and one half ounces to each pound in 24 hours. Individual nursings vary widely in amount, and it is a matter of common observation that the late feedings of the day are less than the early ones. The quiet, apathetic infant needs much less than the restless, overactive, hypertonic baby for the obvious reasons: the variation in metabolism or tissue structure, or perhaps some unexplained endocrine influence.

**Ultimate Weaning.** Given a mother with an adequate breast-milk supply for the infant's needs, when is this act to be terminated? This again is an intangible point, and custom in various parts of the world has dictated varying answers. Surely when no other satisfactory source of milk or supplemental food is available in primitive cultures and in levels of insecure standards of living, there is no reasonable limit to the period of lactation. This fact, more than any other, accounts for the dicta which exist in the history of infant feeding, where it was recommended that infants be fed from the breast—"until all the teeth have erupted"; "for two years"; and knowledge from explorers tells us that women in Greenland and in Mongolia continue to supply the child with their milk until the fifth or sixth year.

In modern civilization, propriety and the adequacy of other foods make long nursing untenable. With the introduction of supplemental solids as early as is now practiced, the urgent need is long past, and prolonged lactation becomes questionable. A maxim stated by someone is as follows: "Breast milk is nutritionally better than any other milk until the fifth month; any

other type of milk is as adequate from the fifth to the seventh month; and after that period any other milk is better." This is not to be taken as literally as it appears, but it condenses in cursory statement the general practice, and the epitome of modern pediatric thought. The fears of weaning during the "first summer" or the "second summer" which still hover over the modern baby date back to the day when a certain mortality was exacted in any summer that a baby was weaned, because of unclean supplementary milk and absence of adequate refrigeration facilities. These hazards do not exist today, and any time of the year is as safe as another to wean a baby.

The weaning easily can be accomplished by employing the reverse of the rule that invites milk secretion. By leaving some milk in the breast at every feeding and having the baby nurse just when the mother is uncomfortable, and then only until the discomfort is relieved, will soon bring about cessation of the secretion in most nursing mothers. The use of various endocrine substances in the modern day makes this less of a problem, but these preparations are rarely needed except at the initiation of lactation.

Before 1938 when post-partum lactation was not desired or when cessation of milk secretion in the nursing mother was indicated, the patient was restricted in her fluid intake, the local application of ice, saline purgatives, intramuscular injections of camphor and oil, and the administration of analgesics were used to provide some measure of relief. Since that time estrogen has been widely used in various forms and doses. A recent manual on pharmacological products lists over 50 such products prescribed orally and by injection (124). Dondek *et al.* (50) give an excellent outline of this recent evolution of androgen therapy for breast engorgment and lactation control, while also reporting on a long-acting androgenic hormone (testosterone *cyclopentylpropionate*) by the single injection of 100 mg. They state that the results in their experience are better than heretofore obtained by the repeated administrations of estrogen and other forms of androgen.

### VITAMIN ADDITIONS IN BREAST FEEDING

Singularly enough, human milk, the reputed "perfect food for the human young" is deficient in vitamin D. In a former period not-too-long-ago when rickets was a common disease, it was not

unusual to see flagrant rickets appear in infants fed completely on human milk with no food supplements or vitamin additives in the first 6 to 10 months of life. A complete discussion of the vitamin content of human milk and its required supplementation is found in Chapter 9.

### **SUPPLEMENTAL SOLID FOODS TO BREAST FEEDING**

The addition of solid foods to the dietary of the neonate who is fortunate enough to be completely breast-fed is the same as with the bottle-fed baby, and is discussed in detail in Chapter 8.

### **CLINICAL HINTS INVOLVED IN SUCCESSFUL BREAST FEEDING**

#### **Preparation of Prospective Mothers' Nipples**

It is a matter of common knowledge that most primiparous mothers arrive at the act of breast feeding with the nipples soft and unused to the ordeal exacted from them by a vigorously nursing infant. This accounts for much distress, both organic and psychological, and inadvertently accounts for the premature weaning of some infants. As part of the prenatal care, the mother should be instructed early in the pregnancy to scrub the nipples regularly with a soft, then harder brush, followed by alcohol, in an effort to harden the skin of the nipple and render it more resistant to the trauma induced by the sucking infant.

In an attempt to weigh the causes of fostering the decline in breast nursing, there has been much emphasis of late on the proper care of the breasts and nipples, both prenatally and postnatally, in obstetric and pediatric literature. Abrahamson (1) has a bibliography of over 50 articles extolling breast feeding, and suggesting among the causes of failure that the care of the nipples is at fault. Aldrich states (3): "Failure of breast feeding reflects a real impoverishment in human lactation and probably some inefficiency in ability to establish proper technics and prevent such complications as inverted and cracked nipples, breast infections, and excessive engorgement. Improved technics in subsequent years may increase the number of breast-fed babies."

#### **Position of Infant During Nursing**

Inept instruction to the mother often accounts for the failure of the baby and mother to learn the art of breast feeding. Too often the mother in the hospital bed overlies the infant, with the baby's nose buried in the redundant breast tissue, making

him struggle for air with the resultant cryptic note on the nursery chart: "*Infant refuses (sic!) to nurse.*" The child lying on his back is in a most "unphysiological" position from which to drink milk. The mother, supported by one elbow in the bed, soon becomes fatigued and increases the difficulty of presenting the nipple to the suckling. As early as possible, the mother should be sitting erect with her back and arms well supported. The baby should be held at about a 45-degree angle, and the nipple PRESENTED to the infant in this position, with a chancee to retreat if his breathing is occluded. Patience and teasing should be assiduously employed to awaken the various innate reflexes of the baby.

### Exercising Instinctive Reflexes of the Infant

Stimulation of the lips of the infant with the maternal nipple excites the most fundamental of all reflexes. It may be demonstrated easily with a wooden tongue depressor in almost any full-term infant, and easily can be employed with the nipple of the mother.

The so-called "*tactile reflex*" is another aid, of which most physicians and many nurses are not aware. It may be demonstrated by any observant and experienced multiparous mother, who is often amused at the efforts of the nursery attendants to induce the baby to reach for the nipple. When the cheek opposite the side of the breast is pushed toward the nipple in an effort to contact the baby's lips to the nipple, the baby immediately turns toward the side from which the stimulation comes—which is AWAY from the nipple. After frantically pushing the infant's cheek toward the nipple, and the baby as determinedly and instinctively reaching toward the stimulating hand, the nurse gives up and records on the chart one of those classic aphorisms, "*Baby fights breast*" or still worse, "*Infant apparently does not like the taste of breast milk,*" and half of the battle for breast feeding is lost. If the finger or nipple gently strokes the cheek ADJACENT to the breast, the baby follows this tactile stimulus and is invited toward the task at hand.

### Overfeeding in the Breast-fed Infant

This state of overfeeding is indeed a rare one, but it has received much attention in earlier discussions of breast feeding. The premise that every mammal knows its own capacity must

be accepted as a fact. Regardless of the amount of milk available, the infant sinks into the well-known postprandial stupor, as does any lion or reptile after it has eaten its fill. Any regurgitation or paroxysmal crying immediately after breast feeding must be attributed to some other cause than overfeeding. Infants have been known to take as much as 10 ounces at one time in the newborn period with neither losing any of it nor suffering any distress. The converse, or underfeeding, is the most usual cause of crying after the breast has been emptied.

### **Does Human Milk Agree with All Babies?**

To prove that any mother's milk "does not agree" with her infant is an excuse bandied about too loosely, and it marks the author of this statement as inexperienced, or trite in judgment. It would be impossible to prove this point without ruling out many other very likely factors. It may be shown that a given infant could be allergic to mothers' milk *per se*, but any gastrointestinal disagreement is a factor difficult to demonstrate if one is acquainted with all of the other causes of digestive distress that may play a role. Diligent search for some other cause of nutritional disability should be sought rather than to rely on this easily refutable platitude.

### **Substitution of One Supplemental Bottle Feeding in the Completely Breast-fed Baby**

It is every physician's experience to meet sometime in his practice the "*breast milk addict*"—a baby who refuses any other source of milk except from the human breast. Flavor is not a factor, because human milk presented in a bottle will not deter him from his fixation. The author has had the experience of such an infant refusing all food for one week, with an alarming weight loss, until only gavage saved this infant from possible threatened starvation.

To meet the problem of this unusually determined youngster, as well as the embarrassment when sudden weaning becomes necessary because of death or illness of the mother, a good routine is to introduce some easily prepared bottle-fed food as a *supplemental* or *complete* feeding in a bottle once or twice a week, despite the adequacy of the breast flow. This not only indoctrinates the baby to a familiar technic, but also gives the

mother an opportunity to escape from a steady routine occasionally, which proves a boon to her psychologically, and usually improves the flow of her milk the rest of the time because of this temporary surcease from regularity and boredom. Many concessions must be made in the present day to the demands of social custom, which were not necessary to concede in former and sterner years of pioneer existence.

The choice of milk mixtures for *supplemental* (substitute for breast) feeding is identical to that for *mixed* or *complemental* feedings which is discussed fully in Chapter 4.

### Routine Weighing of Babies

No doubt many millions of infants have grown to childhood successfully without the need of weight scales to measure their progress. In the modern and urban day it has become one of the accoutrements of the home nursery, as common as are diapers. For the first three months of the baby's life, it does afford a valuable assurance to the parents. It gives to the medical advisor of the infant a secure basis in rationalizing growth and development of that baby, and to the parents a correct perspective as to these tangibles. Weighing of the baby once per week would be frequent enough to demonstrate satisfactory growth, although the author has known of formulas being changed twice daily by physicians when weight gain had not been demonstrated in one day!

Weighing the baby before and after breast feeding is also an acceptable practice, unless the results are taken too academically by the parents, and if not performed too ritualistically. The experienced observer can note by other signs that the human milk supply is falling off, but weighing does present graphically and accurately how much food an infant is ingesting and whether his theoretical needs are being met.

### Chemical Analyses of Human Milk

The chemical assaying of the mother's milk is no longer practiced, since the milk of any mother will not vary one per cent in solids, fat, protein, or carbohydrate, regardless of the diet of the mother. This useless act is a gesture of acknowledged despair on the part of the physician when it is recommended. It admits his lack of experience and knowledge of present-day procedure.

### Stools of the Breast-fed Infant

Special mention should be made of the stools of the breast-fed infant because of their characteristics, which often lead to erroneous conclusions to the new mother and to the initiate in infant feeding. They are unlike those of any other food. The high fat and carbohydrate and low protein content of mothers' milk encourages a fermentative rather than a putrefactive action in the intestinal tract. The dried residue of the stool contains from ten to thirty per cent of fat derivations; about 8 per cent of salts, bile pigments, intestinal secretions, epithelial cells; and a large amount of bacteria. The protein and sugar are completely absorbed.

The physical characteristics of the human milk stool are soft mushy, never hard or formed, and have an egg-yellow color. The slightly acid or sour milk odor which is not unpleasant is most characteristic. The color may vary even normally from white to green without anything being abnormal. The fat curds, so characteristic, do not and should not appear in any other kind of stool from other foods, but are normal in the human milk stool. The number varies between one after each feeding to one every second to fourth day, which is normal and again is the opposite to the stools from other foods. That which would seem like an abnormal number on any other food is characteristic of the human milk stool.

This marked contrast to all that is considered pathognomonic in bottle-fed babies' stools is the source of confusion to the neophyte. It would be well worth-while if the new-comer to infant feeding would observe these essential facts and make it a point to view repeatedly in the newborn nursery the characteristics of the stool of the breast-fed baby described above, for his own information and experience. (See Chapt. 10)

György states that human milk stools have an acid reaction while those of infants fed on cows' milk are neutral or alkaline. In contrast to the mixed intestinal flora of infants fed on cows' milk the bacterial flora of human milk stools have a proliferation of *Lactobacillus bifidus* and its mutants. This organism comprises about 98% of the human milk intestinal flora, and its prevalence together with the acid fecal reaction have been claimed to have a beneficial effect in the suppression of pathogenic or otherwise harmful intestinal bacteria. The presence of specific

fermentation products like lactate, acetate and formate furnish a specific contribution to this anti-bacterial effect (69).

### So-Called Galactagogues To Stimulate Human Milk Secretion

It has been the dream of the therapist to administer to the lactating mother some agent which would stimulate her flow of milk. Every manner of "*recipe*" has been handed down to us by our medical predecessors as efficient galactagogues, varying from quasi-scientific prescriptions to superstitious acts of folklore, to insure increased lactation. Various tonics containing strychnine and bitters, ale and beer, three quarts of milk per day, and many other hopeful "*precursors*" have been suggested and widely used. It may be said truthfully that any act or agent administered to the nursing mother which seems to increase the quantity of milk carries with it the strong implication of psychic suggestion rather than any organic stimulation to the secretory function of the breasts. Proof of this is found in the presence of a *let-down reflex* (*loc. cit.*), the inhibition of which interferes with the ejection of the secreted milk. (See pages 50 and 51) as to newer data on stimulation of *let-down reflex* and the artificial effect of the use of endocrine substances in increasing lactation).

### Alternate Versus Both Breasts at Each Feeding

Whether to feed one breast at alternate feedings or to feed both breasts at each feeding is a controversial subject which finds strong proponents for either view. In the literature and among clinicians, one finds ardent support for both positions.

The strongest argument for feeding alternate breasts at each feeding is to prevent sore nipples and their sequel, which is often a phobia in most hospitals. The other equally forceful argument is that by alternate feeding, each breast is completely emptied and thus stimulated by the infant to fill again (168). Witkin (187), a strong exponent of bilateral breast feeding, thinks that experimental evidence is strongly in favor of two-breast feedings. Since one breast stimulates the other when being nursed, it is thought that this suggests a hint from Nature that it too should be emptied. Turner (173), an ardent disciple of the latter school of thought, states cryptically: "The dairyman would not think of milking one half of the cow's udder at one time and one half at another." This analogy to human breast

nursing is questioned since no cow is milked five to seven times daily.

It appears that if the nipples of the mother can bear the active manipulation of a strong nursing infant, it would be well to make available the milk of both breasts at each feeding. Any milk remaining in either breast could be expressed by breast pump or manually, thus emptying and subsequently stimulating the breast to further secretion. Individual needs should be respected rather than broad generalizations set forth.

### **Mechanical Means of Emptying the Breasts**

Much has been made of the physiological principle of stimulating the breast by repeatedly and completely emptying it, if not by the infant, then by some mechanical means. Sedgwick, one of the earliest advocates of this principle, makes the trite observation that "Zolocisti has suggested that we put the husband to the breast in these cases. While this undoubtedly would be a very effective method, it is a trifle too unesthetic to prove extensively practical" (2).

The emphasis on emptying the breast is reiterated through the literature at various periods, and many mechanical devices have been designed for this purpose. Expression by hand was enthusiastically advocated and widely popularized by Sedgwick about 1920, and was reported very successful in his experience, and in that of others. His exact technic is quoted frequently.

Richardson repeatedly extols the virtues and simplicity of manual expression, and his description of this exact procedure is here quoted (138): "The proper way to empty a breast is to 'milk' it . . . Grasp the breast just back of the areola between the thumb and first finger of the opposite hand. Close the thumb and finger on the (portion) of the breast tissue (lying between), drawing them forward with a slight milking motion . . . At first the milk may come in drops; but after a few manipulations, a spurting stream should be obtained. This has a tremendous psychological effect on the mother and her relatives." Elsewhere, he says (139): ". . . keen interest is manifested whenever it is demonstrated before a group of physicians, and their evident surprise when they see jets of milk spurting six feet or more."

Among the mechanical devices used, the electric breast pump is probably the best known and certainly most efficient. These are used most often in hospitals, since their expense prohibits

the purchase of one by any family. In metropolitan and populous suburban areas, enterprising pharmacists and physicians' supply houses rent these pumps by the week. An inexpensive, water-type breast pump, easily adaptable to any water faucet, is of valuable use in the home where this is found necessary. The glass hand pump, obtainable at any pharmacy, although inexpensive, is also inefficient and adds nothing more than a gesture toward solving the problem. It may be also said here that the glass nipple shield on which the infant nurses on a rubber nipple, attached to a glass shield adherent to the areola and the breast, is most ineffective and laborious. Most mothers find it difficult to attach the shield securely to the breast to insure the vacuum necessary for its use, and the baby, except the strongest of nursers, soon becomes exhausted at the double suction necessary to extract milk from the nipple through this mechanism.

*Does Mother Nature adjust the composition of milk to the needs of each species, or have the different species adapted themselves to their own milk in order to survive?*

B. L. HERRINGTON  
(*Milk and Milk Processing*,  
McGraw Hill Book Co.,  
New York, 1949.)

## Chapter Four

### COMPUTATION OF MILK FORMULA MIXTURES

IT WOULD BE platitudinous to state that a physician should utilize all of the adjuncts and appurtenances of his profession to the greatest advantage of his patient. There are many antibacterial and antibiotic agents available to combat infections, and hence it would be an error of judgment indeed if any physician relied on only one of these many agents for his needs when so many more specific ones are available. So it is in the field of infant feeding, albeit the indications for selective therapy are not as specific. There is a multiplicity of infant foods at hand for any particular need and it becomes a rewarding part of practice to make use of these many helps which are extant. To rely on only one of the 25 *one-formula bottle foods*; to evade the versatile advantage of using adjustable and flexible *milk-base mixtures*; and to avoid as too complex the use of many of the *special purpose milks* when specific indications are present—to accede to these various escapes from responsibility is not to fulfill the expectations which the medical training of the physician have provided. In Chapters 5 and 6 there are listed all of these many assists for successful feeding requirements. Here we will elaborate on one of these classified groups which lends itself to simple illustration and explanation.

Many medical students, internes, residents, as well as practicing physicians have been led to believe by some subliminal or more overt indoctrination that computing milk base mixtures is either complex, outmoded, or inferior to the ready-made, one-formula preparations on the market. Milk formula construction is most simple when a few easily-remembered factors are kept in mind and when some experience has been obtained. It will never be outmoded to make up a special milk mixture for an infant, because it embraces the fundamental precepts of basic nutritional

principles and chemistry to which the physician is trained. These milk-base combinations are equal and often superior to the immobile, pre-modified preparations. This superiority is not necessarily nutritional but is inherent in the fact that specifically-constructed mixtures exemplify the long-accepted truism that an infant's needs are individual—that the prescribed milk food should be made to adjust to the infant and not the baby to fit the formula.

There are those who would refute the suggestion as to the inflexibility of the pre-modified mixtures by the reminder that human milk is the original constantly immobile food, and which undergoes no modification of content from the post-colostrum stage through the entire period of lactation. The answer to this premise is that “the milk of every mammal is specific for its young—and man is no exception” (18). Many efforts in the past and present have been to approximate human milk by other bottle-fed milk substitutes in adjusting the protein, fat, carbohydrate and mineral content, from whatever source, to adapt them to the needs of the infant digestion and nutrition. An intangible factor found in human milk has eluded man's efforts to place this ingredient in a can or bottle for infant consumption.

It is to orient the physician and the physician-to-be in the simple precepts of formula construction that the next few pages of this chapter are written. These directives are presented almost exactly as they appeared in the first book, with little revision, since many kind things were said by reviewers and critics of the earlier text concerning the simplicity by which the newcomer to the subject had had presented these elementary facts. The interested reader of this section is referred to Chapter 2 for the fundamental principles of chemistry and physiology involved in milk digestion. He would do well to consult the summarizing tables in that chapter, and is also referred to Chapters 5 and 6 for a well-ordered and useful outline of all of the foods that are available for infant feeding at the present time.

### **Basic Nutritional Requirements**

In the computation of an infant milk mixture, certain essential nutritional needs must be fulfilled, and these have been more or less arbitrarily agreed upon by infant nutritionists. They are

here presented in an abbreviated form, and the reader is urged to seek in quoted references for the origin and scientific authority of these specific requirements (89) (18) (157).

1. *Proteins*. One and one-half ounces of cow's milk per pound of body weight equals 1.5 gm. of protein per pound, which equals one tenth of body weight. An excess of protein is well tolerated.

2. *Carbohydrates*. One-tenth ounce per pound of body weight equals 1 ounce per 10 ounces of milk prescribed, which also equals 1 per cent of the body weight. One third of the carbohydrate should be derived from the milk of the mixture, and the remainder added in the form of starch or sugar. Later in the first year the carbohydrate is given in the form of a starch cereal, and the carbohydrate in the milk formula may be reduced at that time.

3. *Fats*. Anywhere from 3 to 5 per cent is included, no specific amount being stipulated. If the fats are restricted, a larger amount of protein or sugar, or both, is required for energy sources. The suitable quantity of fat is supplied in amounts of milk which furnish the required amounts of protein. An excess of fat is not to be desired.

4. *Minerals*. An adequate mineral-salt intake is supplied to any infant when 1½ ounces of milk per pound of body weight are given. Enough iron is stored in the liver of the normal infant (from the hemoglobin breakdown after birth) to suffice until about the fourth or fifth month. This deficiency is usually made up by the addition of the solid food supplements (egg yolk, fortified cereals, vegetables and fruit) which are usually added before this time, except in the completely milk-fed infant who refuses or is not offered these iron-containing foods in the first year.

5. *Water*. The requirement for water varies from 10 to 15 per cent of the body weight, or may be expressed as 1½ to 2½ ounces per pound of body weight. This is supplied in the milk itself, in the diluent of the milk mixture, and supplemented to instinctive demands by offerings of water and fruit juices between feedings.

6. *Calories*. The average requirement for growth in the first year is 50 calories per pound of *expected* weight, two thirds of this caloric need being supplied by the milk and one third by the added carbohydrate.

7. *Vitamins.* Any normal infant ingesting 18 ounces of cows' milk, or a comparable amount in a bottle-fed milk food, or its equivalent of human milk (24 ounces), receives all the vitamin A and all the vitamin B fractions (including vitamin B<sub>12</sub>) needed for optimum growth. There is a deficiency of vitamins C and D in both human and cow's milk, and these should be supplemented as early as possible in the first month of life. Thirty to 50 mg. of vitamin C, and *no more* than 400 I.U. of vitamin D, should be administered daily in any acceptable form.

Unnecessary and excessive vitamin prescribing and ingestion are to be deprecated. Infants given a daily dose of 2000 I.U. of vitamin D achieve less growth than infants receiving 135 I.U., and far less than those given 400 I.U. In careful studies on premature infants it has been concluded that there appeared to be no difference in efficacy in the various types of commercially available vitamin D preparations in preventing rickets or promoting growth (165). (See page 207.)

**Summary of Formula-Constructing Factors.** Further condensation of the previously-mentioned nutritional requirements, together with additional factors in the rapid estimation for formula construction, are listed here:

WHOLE MILK—1½ oz. per lb. of body weight

EVAPORATED MILK—1 oz. per lb. of body weight

ONE-FORMULA LIQUID MIXTURES—usually 1 oz. to 1 oz. of diluent unless otherwise specified

ONE-FORMULA DRY PRODUCTS OR DRIED WHOLE MILKS—usually 1 tbs. per 2 oz. of diluent unless otherwise specified

CARBOHYDRATE— $\frac{1}{10}$  oz. per lb. of body weight or 1 oz. per 10 oz. of milk used

QUANTITY OF FOOD AT ONE FEEDING (starting average):

1 to 3 months—age in months plus 3 (oz.)

3 to 6 months—age in months plus 2 (oz.), not to exceed

8 oz. at one feeding

TOTAL QUANTITY FOR TWENTY-FOUR HOURS—amount required at each feeding times 5 to 7 feedings

DILUENT—almost always water, cereal waters (barley, rice, farina), or vegetable waters (water strained from cooking vegetables)

(Another help on deciding the initial 24-hour amount an infant might require is suggested by Williamson (185). Accepting that the infant will need 50 calories per lb. of body weight, and that 1 oz. of milk supplies 20 calories, the following equation would give a practical answer to the 24 hr. offering:

weight of infant × caloric re-

quirement per lb. (50 calories)

calories supplied by 1 oz.

of milk (20 calories)

total ozs. of formula in

volume required in 24 hrs.

It should be mentioned again for special emphasis that the above are only starting rules for the average infant. It might be said that there are more exceptions to the basic rules above than there are adherents to them. They are presented only as guidons to the novice at formula construction so that he may have some starting point from which to foray in either direction. The infant is always the rule rather than a prescribed set of dogma. Infant feeding intelligently executed is always an *individual* problem rather than a generalization. If growth succeeds, if the infant is satisfied, and if the food mixture is well tolerated—it is then left as it is computed. Otherwise, more or less milk, or CHO is added or removed, as the needs dictate.

Before proceeding to an example of how the foregoing rules are utilized in the construction of a formula, Table 13 containing calorie values is presented for quick reference.

TABLE 13  
COMMONLY-USED CALORIE VALUES

Often-used Foods	Cal. Per Oz.	Often-used CHO	Cal. Per Oz.	TbIs. Per Oz.
Human Milk.....	20	Cane Sugar	120	2 (dry)
Whole Cows' Milk.....	20	Dextri-Maltose	110	4 (dry)
Evaporated Milk.....	44	Karo	120	2 (fluid)
Condensed Milk.....	126	Cartose	120	2 (fluid)
Protein Milks (dry).....	144	Sweetose	120	2 (fluid)
Dried Milks.....	135-150	Dexin	115	6 (dry)
Skimmed Milk.....	10	Banana Flakes	100	5 (dry)
Goats' Milk (evap.).....	38	Lactose	120	3 (dry)
Casee.....	105	Honey	120	2 (fluid)

**Formula Computation.** A simple problem with which to apply the basic rules of formula computation would be the food needs of an infant weighing 10 lbs. at 2 mos. of age, having weighed 6 lbs. at birth. This infant would probably take 3 oz. more than his age in months (2) which would be (2 mo. plus 3 equals 5) 5 oz. per feeding. In 24 hours he probably would be satisfied with five feedings; hence, he would need 25 oz. in a total 24-hour period.

EXAMPLE—WHOLE MILK MIXTURE

1½ oz. whole milk per lb. of body weight	
(10 lb.)—	Milk, 15 oz. = 300 cal.
1 oz. CHO per 10 oz. milk used—Cane sugar, 1½ oz. = 180 cal.	
Diluent to make up total 24-hr.	
amount	Water, 10 oz.
5 feedings of 5 oz. each—	<u>25 oz. = 480 cal.</u>

Calorically, this should effect normal growth since it provides 48 calories per pound. Should it not provide normal weight increase of about 5 to 7 oz. per week, or should the infant fail to be satisfied by evidencing signs of hunger, the milk proportion could be increased, or the total amount be enlarged, or additional CHO added, or all of these could be changed to fit the infant's needs.

EXAMPLE—EVAPORATED MILK MIXTURE

In calculating a formula with evaporated milk and a corn syrup for the same hypothetical infant, the construction would be as follows:

1 oz. evaporated milk per lb. body weight—	
	Evap. milk, 10 oz. = 440 cal.
1/10 oz. CHO per lb. body weight—Corn Syrup, 1 oz. = 120 cal.	
Diluent to make up total 24-hr.	
amount—	Water, 14 oz.
5 feedings of 5 oz. each—	<u>25 oz. = 560 cal.</u>

With this mixture the calories are increased to 56 per lb., which might easily be tolerated by said infant, especially if he were active and hungry and needed more food. A much larger amount

of volume as well as caloric value of evaporated milk may be used for a greater range of utilization than with whole milk mixtures.

#### EXAMPLE—POWDERED PRE-MODIFIED MILK MIXTURE

Using the same infant for one of the powdered milks with a CHO already being added, the formula would be:

Total volume requirement for	
24 hrs.—	water, 25 oz.
Any standard “one-formula” dry	
milk—	12 tbs. (1 tbs. per 2
	oz. diluent)
5 feedings of 5 oz. each—	25 oz. = 500 cal.

These foregoing illustrations are recorded as the simplest starting points in beginning to construct a formula mixture. If the stools are too firm or marble-like, a sugar could be added with greater laxative properties (see Chapter 6). The opposite procedure would be indicated if the stools are fermentative or too loose. There is a wide range of variation to adjust the mixture to serve the individual purpose. It is amazing at times to note the extremes of theoretical tolerance within which infants will progress on various combinations. It is equally surprising to observe the small range within which an infant can stand variations of the calculated limits of milk and CHO. *The individual baby is always the ultimate index.* (See Appendix for relative cost of various bottle-fed milk foods and CHO additives.)

It is a truism that the primary rules listed soon become nebulous to the experienced physician in the daily feeding of babies. It is rare that he begins with any other rule in mind than clinical “instinct.” Only if the baby fails to gain weight satisfactorily does he calculate the caloric value of the food. The well-being of the infant at hand is the criterion to his selection of the kind of food, the proportion to be used, the amount to be taken per feeding, or the interval between. This talent is acquired by the repeated sharpening of the physician’s observational ability, and is analogous to other skills which make up his clinical acumen.

**Fallacies of Too-Frequent Formula Changes.** All too frequently, the observation is made that the existing kind of milk mixture or its specific content is changed too often. Residents in hospitals who are impetuous in their zeal to observe results of their academic efforts, as well as seasoned physicians of wide experience who wish to impress the parents, or who are in desperation, too often indulge in the hasty act of varying the formula with no benefit except the questionable psychological placebo of "doing something." Instances frequently have been met where an infant has had a formula change eight times in ten days, which included five or six completely different types of milk! Clinically or physiologically no observations as to digestion, absorption, or utilization can be made in the short period of 24 hours. Such practices are to be decried since they confuse the picture of the infant's nutritional problem, and no wise clinical conclusions possibly can be drawn even by the most astute and experienced physician in so short a time. If the changes are indicated for psychological expediency toward the parents, a few words of explanation as to what observations are to be made or what desired results are to be achieved will promote their confidence more than the wild orgy of rapid formula change.

Another common error of good judgment often is made on the part of a physician by deliberately changing the existing food mixture or feeding routine of an infant he has not seen before, even when the baby is progressing well and the food is adequate in all factors. These gestures of intolerance of the knowledge of others, or affectation of superior experience, not only are discourteous, but also are unsound physiologically. The author once had the experience of seeing an infant who had varying small amounts of *six different* carbohydrates in the same formula, and all at one time! The total caloric intake was not excessive, the stools were normal and the infant was progressing well. No change was made until some time later when the explanation was given to the mother that the baby "does not need so complex a formula now that he is older." It is obvious that no infant's gut is responsive to the slight shades in difference of six varied carbohydrates simultaneously, but another physician's confidence was

maintained and perhaps the author's own status of integrity was preserved. (See Chapter 10, page 243 for further discussion.)

The authoritative and ponderous manner by which some physicians adhere to hobbies in formula-prescribing would be amusing if it were not for the fact that by these futile gestures they expose a fundamental deficit of knowledge and an intolerance of scientific truths. By neglecting to improve their sum of learning relative to the principles involved in infant feeding, and by deserting a native scientific inquisitiveness, they become inbred by their own small successes and empirical experiences. The only redeeming feature of their vanity is that rarely is an infant endangered, since the tolerance of the gastroenteric physiology of the baby is so liberal. The harm, however, is to the physician himself, whose integrity and scientific honesty is impugned whether he is aware of this fact or not. He is led astray from scientific principles which should govern his reasoning, and he perverts his training by his petty achievements. The practice of didactically changing from one brand of evaporated milk to another in a given milk mixture for a specific infant, or of extolling the merits of one premodified milk product as the universal food for all babies—is mute evidence of a single-mindedness and a limited scientific vision. Great truths and new discoveries in the field of infant nutrition are never imputed by closed minds and narrow perspectives. This aphorism is applicable in other fields of clinical medicine as well.

### COMPLEMENTAL OR MIXED FEEDINGS

When every effort has been made to protect the suckling's supply of human milk and when this is found wanting, the addition of other sources of food is indicated. Dr. Joseph Brennemann reiterates the following forceful statement in many of his papers on the subject: "The normal breast-fed infant who does not vomit, has no diarrhea and is not gaining normally in weight is not getting enough to eat and should have more (18)!" He was also known to remark to his interns and students that most of the crying by a baby in the first few months of life, in his experience, was due to hunger. The latter statement may not be sustained fully in the light of modern interpretation of infant behavior, but it still

remains as the most prominent cause when supported by the experience of the physician who is directing and solving the common problems of the everyday infant in his office and baby clinic.

The introduction of additional food to the baby's needs may be a temporary gesture with the hope that the human milk supply will return, and still more hopefully, that it will increase. Or it may be the beginning of the inevitable weaning that too often follows.

**Indications for Complemental\* Feedings.** There are no exact criteria as to when the infant needs additional food from some other than human breast source except those in the judgment of the attending physician. Arbitrarily, the following factors would influence the decision:

1. Failure of weight gain or continual loss of weight.
2. Signs of hunger as crying, searching movements, with the mouth and hand-chewing, an hour or two after the previous feeding.
3. Evidence of decreasing human milk as recorded by weighing before and after breast feeding. (The amount of human milk required for an infant to gain satisfactorily is estimated to be  $\frac{1}{6}$  to  $\frac{1}{7}$  of its body weight, or grossly  $2\frac{1}{2}$  oz. per pound of body weight in 24 hours.)
4. Ingestion of large quantities of water at frequent intervals.

**Choice of Bottle Foods for Complemental Feedings.** Any food seems to suffice and be more easily digested by the baby when there is some human milk available, the latter seeming to augment or facilitate the digestion of the bottle food. It would be good practice to supply a mixture as would be prescribed for a supplemental feeding. Any of the powdered or liquid milks completely modified and with CHO added would suffice, making it easy of preparation with the mere addition of water.

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\* COMPLEMENTAL will be used throughout the text to imply "that which is added to make a whole"; SUPPLEMENTAL as "that which is added to supply a deficiency." A SUPPLEMENTAL feeding is one to be used in place of one or more single breast feedings; a COMPLEMENTAL feeding is one which is used in addition to a single human milk feeding to complete that feeding.

In many nurseries, a *house formula* is provided, consisting of whole cows' milk or evaporated milk, diluted with water, and two- to three-per-cent of carbohydrate added (110); or one of the many one-formula products. There may be any variation of food used in addition to those mentioned for complemental feeding, including the use of sugar solutions (5% or 10% dextrose; BETA LACTOSE<sup>®</sup>), calcium caseinate solutions (CASEC<sup>®</sup>), boiled half-diluted skimmed fresh milk, powdered whole milk well-diluted without carbohydrate. See page 59. The ultimate selection depends on the purpose and the end-result which the physician has in mind for the individual problem at hand whether fluid or caloric foods. Except for the premature infant, almost any mixture will be well received and tolerated if there is a normal digestive system functioning, and if some human milk is available.

**Amount of Complemental Feeding.** The amount to be offered as a complement to the breast feeding will depend on the quantity taken by the baby at the breast. The gross rule as to the total quantity offered to any baby is roughly the age in months, plus three ounces, for the first three months. An infant is offered all he will take in a given period of 10 to 12 minutes from the breast, and the remainder which he did not get from his expected intake, is presented. Another computation would be to calculate his needs calorically (50 calories per pound of body weight), and add to the difference, which he did not get at the breast, his required addition in calories. Still another method--since a baby needs roughly two and a half ounces of human milk per pound of body weight in total feedings for 24 hours--would be the difference between the amount gotten at breast and the required quantity, and this would be the amount of the complementary feeding. These are the technical ways of computing an infant's additional needs.

The most practical method, however, would be to add arbitrarily a fixed quantity of substitute milk food to follow each breast nursing, and let the infant decide how much is needed--merely by *feeding to capacity*. Since the breast which needs to be complemented will perforce be irregular in yield, an *exact* difference would be difficult to compute. It is therefore much more

practical even if a little uneconomical, to offer the baby two or three ounces and discard the amount not taken. The only deterrent here is that many parents will feel duty bound to force the entire amount into the infant, either because of a strong economic streak or merely because the amount was so prescribed and the youngster has no choice. This, of course, is strongly decried, and even at this early age is the foundation for later feeding problems.

*It must be obvious that the scientific method cannot be properly taught by just a lecture or only a book. It is not a static thing as is knowledge at a given moment, but a dynamic or functional process which is best learned by direct experience. . . .*

SAMUEL C. HARVEY

("Objectives of Medical Education,"  
*Pediatrics*, [Part II] 22:195, 1958.)



FIG. 3. All Known Available U.S. and Canadian Bottle-Fed Infant Foods (seventy-three) as of June 1, 1959.

## *Chapter Five*

### BOTTLE-FED (*ARTIFICIAL*) INFANT FOODS

**T**YPICAL of the American industrial scene is that of private enterprise being prompt to supply a product when the need has been demonstrated. Not only is one such product made available in this situation but also do competitive products appear, with price, quality and distribution being factors to the ultimate consumer.

The field of infant feeding is no exception to this truism of industry. The manufacture and presentation of products for the use of the bottle-fed infant represents a tremendous phase of manufacture and marketing. From 1946 to 1954 over 3 million newborn infants were registered annually in the United States, and since 1954 there have been over 4 million infants born yearly in the same registration areas (127). It has been shown that 79% of infants leave the maternity hospital with bottle feeding (109) as compared to 62% ten years previously. If this should indicate a trend for the future, the need for substitute infant milk foods for human milk would constitute an ever-increasing market and sales potential for the infant food industry. It has been conservatively estimated that at present retail prices the average infant's first-year dietary (including solid additions) costs \$170 (\$80 if breast-fed). If only half of the 4 million annual neonates would receive the ideally-accepted diet in the first year, over \$340 million would be spent. The remaining 2 million infants would of necessity be fed some human milk substitutes which might hypothetically raise this figure for the food of the first year to over half of a billion dollars (see page 187).

Into this breach the infant milk and food industry has come to fill the need. In this chapter will be listed substitute-human milk, bottle-fed foods presented to the physician by the manufacturers. All of these foods reflect some proven laboratory and nutritional need, and perhaps nowhere in industry is the product presented with more critical evaluation than in this specialized field of the

infant feeding market. In 1952, listing all of the over-200 brands of evaporated milk as *one*, there were 78 such infant milk foods listed and described in the antecedent of this book. Since then 24 have been discontinued (Tables 16-26) and 24 new ones added, making the net total 78 as of October 15, 1959. At the same time (1952) there were 27 carbohydrate modifiers available while at present there are 26 accessible (see Chapter 6).

### MULTIPLICITY OF PRODUCTS

To the novitiate physician and to the established practitioner in this field the multiplicity of foods is confusing and seemingly beyond the grasp of one person. Truly as Brennemann so wisely philosophized on this subject—"We have come from a *chaos* of complexity to a *chaos* of simplicity" with the multitudinous preparations available. Yet the same situation obtains in the field of pharmaceuticals, with a great number of antibiotics, sulfonamides, tranquilizers, antispasmodics and many other proprietary-named therapeutic agents. Indeed this is a common formula in industry at large with automobiles, fuels, building equipment, household utilities and other products of our industrial resources appearing in profusion in America. There is presented to the consumer or prospective purchaser *the burden of choice* as to which of the many well-qualified products is the one to be selected. This state of a competitive market indirectly accrues to the advantage of the ultimate consumer by creating a product of high quality and reasonable price, than if a monopoly existed.

In this chapter it is hoped to clarify that which seems complex by classifying the plethora of products in orderly fashion, and making apparent the duplication which adds to their total number. Any such categorization must be arbitrary—any kind of grouping could be made by anyone familiar with the field. The listings here presented are more efficiently made than in the previous book of 1952, and which incurred favorable and good reception in that publication.

### PRINCIPLES EMPLOYED IN THE MANUFACTURE OF BOTTLE-FED INFANT FOODS

By understanding the uses and structure of each product offered by the bottle-fed food industry, certain chemical or physio-

logical and nutritional principles become apparent. These essentials are accepted by the authorities on infant nutrition or reflect some laboratory fact which has become evident—albeit stress is often placed on a product in its promotion which is not always regarded as vital as is publicized. When these elementary principles are examined, the complexity and understanding of the many products becomes less nebulous to the confused physicians and others who are interested in the field. Following are these essentials proposed by the author in an effort to help, in one way, to simplify that which has been made to seem complex:

#### I. Proteins

- A. Modifying calcium caseinate curd by: boiling, evaporating, drying, homogenizing, enzyme digestion, acid, alkali, or cereal water addition.
- B. Replacing or changing protein fraction (lactalbumin or casein) due to allergenicity of intact protein by: hydrolysis of intact protein; by substitution of vegetable for animal protein or by utilizing the protein of the milk of another mammal.
- C. Reducing protein to simple states (peptides and amino acids) by: enzymic hydrolysis to permit parenteral or oral protein nutrition.
- D. Increasing protein percentage by: addition of a purified protein (as calcium caseinate).

#### II. Fats

- A. Homogenizing fat globule.
- B. Replacing milk fat with more readily absorbable vegetable and other animal fats.
- C. Removing part of fat of milk products (low fat milks).

#### III. Addition of specific nutrients

- A. Adding vitamins and irradiating milks.
- B. Adding minerals (usually iron, calcium, phosphorus, copper, magnesium).

(The "principles" applying to Carbohydrates appear in Chapter 6.)

### SOURCE OF DATA ON TABULATED INFANTS FOODS TO FOLLOW

The information in the tabulated data in this chapter is the result of an inquiry sent by registered mail directly to each of the

manufacturers of known products in the field. There was a 100 per cent return, and the data set down are those of the manufacturers, with every effort made to check all copy, including all decimal points. All of these returns have been carefully filed and will be available should any discrepancies appear as to the claims or authenticity of the data. All of the material presented is the exact copy sent by the manufacturer of the product listed, except where the author has inserted some explanation for amplification of the meaning, or added information which does not change the facts as presented by the inquiry. All of the author's additions are easily identified as being in *italics*. All of the manufacturers were most courteous and cooperative, thereby making this section the complete and helpful compilation which it presents.

It is emphasized that the data presented here are not akin to those found in trade and commercial reference indices, usually supported and promoted financially by advertising organizations or agencies who compile similar commercial data for a service or advertising fee. No company or manufacturer has underwritten this book or any of the units of information in this text. No financial support, honorarium or endowment of any kind have been offered, accepted or solicited in exchange for the data presented in the following tables or textual material.

Every effort has been made to include all preparations of both national and local distribution, limited to the United States and Canada. Should any product for oral use in normal infant feeding have escaped the attention of the author, the omission was inadvertent. Should any such food be known to the reader, the author will be grateful to learn of it and include it in the first reprinting of this edition.

The symbol "®" used with any product indicates that the NAME of the product has been registered at the U. S. Patent Office and can be used only by the manufacturer who has claimed and registered it. This registration does not include anything as to the nature of the product or its content. The symbol "®" is essentially the same as a "Trade Mark" which also implies registration of a name, but not a product. (Information obtained by direct communication with the U. S. Department of Commerce, Patent Office, Robert C. Watson, Commissioner of Patents.)

## OUTLINE OF BOTTLE-FED INFANT FOODS

- I. Milk-Base Dilution Mixtures
  - A. Evaporated Milk (Over 200 brands)
  - B. Bottled Fluid Milks (12)\*
  - C. Canned Whole Milks (Liquid and Dry) (7)
- II. One-Formula (Ready-Modified) Mixtures
  - A. Dry or Powdered (12)
  - B. Liquid (13)
- III. Preparations With Special Functions
  - A. Protein Milks (3)
  - B. Acid Milks (2)
  - C. Hypo-Allergic Preparations (Liquid and Dry) (13)
  - D. Fat-Free (Skimmed) Milks (Liquid and Dry) (6)
  - E. Protein Supplements (3)
  - F. Therapeutic Adjuncts and Dietary Supplements (6)

Total—78

TABLE 14

COMPOSITE CLASSIFICATION OF AVAILABLE BOTTLE-FED INFANT FOODS

- 
- I. MILK-BASE DILUTION MIXTURES
    - A. Evaporated Milk—27 companies in 135 plants process over 200 brands
    - B. Bottled Fluid Milks
      - 1. Homogenized, Vitamin D Cows' Milk—any commercial dairy
      - 2. Certified Raw Cows' Milk—most commercial dairies
      - 3. Goats' Milk (usually certified)—many commercial dairies
      - 4. Skimmed (fat-free) Milk—any commercial dairy
      - 5. High Fat Milk—most commercial dairies
      - 6. Buttermilk—any commercial dairy
      - 7. Enzylac® Homogenized Milk—Medical Dairy Specialties
      - 8. Enzylac® Fat-free Milk—Medical Dairy Specialties
      - 9. Soft Curd® Milk—Medical Dairy Specialties
      - 10. L. Acidophilus Milk ("Kazol")®—Medical Dairy Specialties
      - 11. Lo-Sodium® Milk—Medical Dairy Specialties
      - 12. HI-PROtein Milk—Glenora Dairy (Evanston, Ill.) and other commercial dairies.
    - C. Whole Milks—Canned (liquid or dry—L or D)
      - 1. Concentrated Whole Milk (L)—Cow & Gate Co
      - 2. Dryco® (D)—Borden
      - 3. Foremost Instant Whole Milk (D)—Foremost Dairies
      - 4. Foremost Sterile Whole Milk (L)—Foremost Dairies
      - 5. Klim® (D)—Borden
      - 6. Powdered Whole Milk (D)—Cow & Gate
      - 7. Varamel (fat substituted) (L) Baker Laboratories
  - II. ONE-FORMULA (READY-MODIFIED) MIXTURES
    - A. Dry or Powdered
      - 1. Alacta®—Mead Johnson
      - 2. Baker's Modified—Baker Laboratories
      - 3. Biolac®—Borden
- 

\* Numerals in parentheses indicate number of products in each category.

4. Bremil®—Borden
5. Enfamil® Powder—Mead Johnson
6. Hi-Pro®—Jackson Mitchell Laboratories
7. Humanized Milk—Cow & Gate
8. Lactum®—Mead Johnson
9. Olac®—Mead Johnson
10. Similac®—Ross Laboratories
11. Similac with Iron®—Ross Laboratories
12. SMA Concentrated Powder®—Wyeth Laboratories

## B. Liquid

1. Baker's Modified Liquid—Baker Laboratories
2. Bremil®—Borden
3. Carnalac—Carnation Milk Co.
4. Enfamil®—Mead Johnson
5. Dalactum®—Mead Johnson
6. Eagle Brand® Condensed Milk—Borden
7. Lactum®—Mead Johnson
8. Modilac—Gerber Products Co.
9. Olac®—Mead Johnson
10. Prepared Formula—Cow & Gate
11. Similac®—Ross Laboratories
12. Similac with Iron®—Ross Laboratories
13. SMA-Concentrate® Liquid—Wyeth

(These products were discontinued 1952-1959: *Lactogen*® (Nestle'); *Biolac*® Liquid (Borden); *Dextrogen*® (Nestle')

## III. PREPARATIONS WITH SPECIAL FUNCTIONS

## A. PROTEIN MILKS

1. Protein Milk® (D) Mead Johnson
2. Powdered Protein Milk—Cow & Gate
3. Protein SMA® Acidulated (D)—Wyeth

## B. ACID MILKS

1. Lactic Acid Milk®—(D) (Mead Johnson)
2. Powdered Lactic Acid Milk (Partly Skimmed)—Cow & Gate

(These products were discontinued 1952-1959: *Pelargon*® (Nestle'); *Powdered Lactic Acid Milk*®—Half-Skimmed—(Mead Johnson); *Skimmed Lactic Acid Milk*,® and *Whole Powdered Lactic Acid Milk*® (Borden); *Powdered Lactic Acid Milk with Dextri-Maltose #1*®—Mead Johnson.)

## C. HYPO-ALLERGIC PREPARATIONS (Liquid or Dry)

1. Allergiac (D)—Cow & Gate
2. Dale® Dehydrated Goats' Milk (D)—Cutter Laboratories
3. Gerber's Concentrated Meat Base Formula (L)—Gerber Products Co.
4. Hypo-Allergic® Whole Milk Powder (D)—Wyeth
5. Meyenberg Evaporated® Goat Milk (L)—Jackson-Mitchell
6. Meyenberg Powdered Goat Milk (D)—Jackson-Mitchell
7. Mull-Soy® Liquid—Borden
8. Mull-Soy® Powder—Borden
9. Nutramigen® (D)—Mead Johnson
10. Sobee® (D)—Mead Johnson
11. Sobee® Liquid—Mead Johnson
12. Soyalac (D)—International Nutrition Laboratories
13. Soyagen (D)—International Nutrition Laboratories
14. Soyalac Infant Concentrate (L)—International Nutrition Laboratories  
(Evaporated Milk, Fresh Bottled Goats' Milk and HiPro® are also listed in this category, *loc cit*)

(The following products in this group were discontinued 1952-1959: *Allerteen* (Chas. Kilgore Co.) *Almond Lac*® (Almond Lac Co.); *Capri Evaporated Goat's Milk* (Newcombe-Mead Co.); *Hypo-Allergic*® Liquid (Wyeth); *Miracle Evaporated Goat's Milk* (Milk Foods Inc.).

## D. FAT-FREE (SKIMMED) MILKS (Liquid and Dry)

1. Carnation Instant Nonfat Dry Milk (D)—Carnation Milk Co.
2. Foremost Instant Non-Fat Dry Milk (D)—Foremost Dairies
3. Pet Instant Non-Fat Dry Milk—(D)—Pet Milk Co.
4. Skimmed Concentrated Evaporated Milk—(L)—Cow & Gate

5. **Sunshine Brand Skimmed Evaporated Milk (L)**—Defiance Milk Products Co.
6. **50% Skimmed Concentrated Milk (L)**—Cow & Gate  
(*Fresh Bottled Skimmed Milks*; *Starlac*® (Borden); *Nonfat Dry and Evaporated Skimmed Milks* of many grocery trade brands are also included in this group)

(These products in this category were discontinued 1952–1959: *Partly Skimmed Milk (D)*—(Cow & Gate); *Powdered Skimmed Milk (Borden)*; *Skimmed Milk (D)* (Cow & Gate).

#### E. PROTEIN SUPPLEMENTS

1. **Casec**®—Mead Johnson
2. **Lonalac**®—Mead Johnson
3. **Protenum**®—Mead Johnson

(Discontinued 1952 to 1959: *Protolysate*® (Mead Johnson); *Gerilac*® (Borden); *Lactamin*® (Wyeth); *Peptalac* (Cow & Gate); *Protolac*® (Borden); *Protinal Powder* (National Drug Co.) is not discontinued but it is not recommended for infant use)

#### F. THERAPEUTIC ADJUNCTS AND DIETARY SUPPLEMENTS

1. **Appella (D)**—Winthrop Laboratories
2. **Arobon (D)**—Pittman Moore Co.
3. **Ketonil**® (D)—Merek & Co.
4. **Lofenlac**® (D)—Mead Johnson
5. **Lytren**® (D)—Mead Johnson
6. **Probana**®—Mead Johnson

(*Casec*® and *Kanana*® *Banana Flakes* *loc cit.* are also included here). (*Soyola*® (Wyeth) and *Protoban* (U. S. Vitamin Corp.) have been discontinued since 1952)

TABLE 15

INFANT BOTTLE-FEEDING PRODUCTS, CLASSIFIED AS TO MANUFACTURERS

#### THE BAKER LABORATORIES, INC.

4614 Prospect Ave.,  
Cleveland 3, Ohio  
Baker's Modified Liquid Milk  
Baker's Modified Powdered Milk  
Varamel

#### THE BORDEN COMPANY

Pharmaceutical Division,  
350 Madison Ave., New York 17, N. Y.  
Biolac® Powdered  
Brenil® Liquid  
Brenil® Powdered  
Dryco  
Eagle Brand Condensed® Milk  
Klim®  
Mull Soy® Liquid  
Mull Soy® Powdered  
(also brand name of evaporated milk)

#### CARNATION COMPANY

6045 Wilshire Blvd.  
Los Angeles 36, Calif.  
Carnalac  
Carnation Instant Nonfat Dry Milk  
(also brand name of evaporated milk)

#### COW & GATE (CANADA) LTD.

Brockville, Ontario  
Allergiac  
Concentrated Whole Milk  
"Humanized" Milk  
Powdered Lactic Acid Milk  
Powdered Protein Milk

Powdered Whole Milk  
Prepared Formula  
Skimmed Concentrated Evaporated Milk  
50% Skimmed Concentrated Milk

#### CUTTER LABORATORIES

Fourth & Parker Sts.,  
Berkeley 10, Calif.  
Dale® Dehydrated Goats' Milk

#### DEFIANCE MILK PRODUCTS CO.

Division of Diehl Inc.,  
Defiance, Ohio  
Evaporated Skimmed Milk (Sunshine Brand)

#### EVAPORATED MILK ASSOCIATION

228 N. La Salle St.,  
Chicago 1, Ill.  
27 companies  
135 plants  
Over 200 brands

#### FOREMOST DAIRIES, INC.

425 Battery St.,  
San Francisco 11, Calif.  
Instant Nonfat Dry Milk  
Instant Whole Milk  
Sterile Whole Milk  
(also brand name of evaporated milk)

#### GERBER PRODUCTS CO.

Fremont Michigan,  
Gerber's Concentrated Meat Base  
Formula  
Modilac

**GLENORA FARMS DAIRY**

Evanston, Ill.

Hi-PROtein Milk

**INTERNATIONAL NUTRITION LABORATORY INC.**

11503 Pierce Place, Box 388

Arlington, Calif. Mt. Vernon Ohio

Soyalac Infant Powder

Soyalac Infant Concentrate

Soyagen

**JACKSON-MITCHELL****PHARMACEUTICALS, INC.**

10401 Virginia Ave.,

Culver City, Calif.

Hi-PRO<sup>®</sup>Meyenberg Evaporated Goat Milk<sup>®</sup>Meyenberg Powdered Goat Milk<sup>®</sup>**MEAD JOHNSON & CO.**

2404 W. Pennsylvania St.,

Evansville 21, Ind.

Alacta<sup>®</sup>Casec<sup>®</sup>Enfamil<sup>®</sup> LiquidEnfamil<sup>®</sup> PowderLaetum<sup>®</sup> LiquidLaetum<sup>®</sup> PowderedLofenlac<sup>®</sup>Lonalac<sup>®</sup>Lytren<sup>®</sup>Nutramigen<sup>®</sup>Olae<sup>®</sup> LiquidOlae<sup>®</sup> PowderedPowdered Lactic Acid Milk<sup>®</sup>Probana<sup>®</sup>Protein Milk<sup>®</sup>Protenum<sup>®</sup>Sobee<sup>®</sup> LiquidSobee<sup>®</sup> Powdered**MEDICAL DAIRY SPECIALTIES, INC.**

5875 N. Lincoln Ave.,

Chicago 45, Ill.

Homogenized Vitamin D Milk

Raw Certified<sup>®</sup> Cows' MilkCertified<sup>®</sup> Goats' MilkHomogenized Enzylac<sup>®</sup> MilkFat Free Enzylac<sup>®</sup> Milk

Buttermilk

Lo-Sodium<sup>®</sup> MilkSoft Curd<sup>®</sup> MilkL. Acidophilus<sup>®</sup> Milk**MERCK SHARP & DOHME****RESEARCH LABORATORIES**

Division of Merck &amp; Co. Inc.

Rahway, New Jersey

Ketonil<sup>®</sup>**PET MILK COMPANY**

St. Louis, Mo.

Pet Instant Nonfat Dry Milk

(also brand name of evaporated milk)

**PITMAN-MOORE CO.**

Division of Allied Laboratories

Box 1656, Indianapolis 6, Ind.

Arobon

**ROSS LABORATORIES**

Columbus 16, Ohio

Similac<sup>®</sup> LiquidSimilac<sup>®</sup> PowderedSimilac with Iron<sup>®</sup> LiquidSimilac with Iron<sup>®</sup> Powdered**WYETH LABORATORIES**

Div. of American Home Products Corp.

Philadelphia 1, Pa.

Hypo-Allergic<sup>®</sup> PowderSMA Concentrated<sup>®</sup> LiquidSMA Concentrated<sup>®</sup> PowderProtein SMA—Acidulated<sup>®</sup>**MOST COMMERCIAL DAIRIES**

Homogenized Vitamin D Milk

Certified Cows' Milk

Goats' Milk

Fat Free (Skimmed) Milk

High Fat Milk

Buttermilk

**I. MILK-BASE DILUTION MIXTURES**

It appears to be an axiom that the newcomer physicians to infant feeding tend *to embrace* that which they think is new and *to leave* that which has been established—under the delusion that it is fashionable and erudite to be modern in all things. One-formula mixtures are not exactly of recent origin having been extant before the turn of the century. Cows' milk-dilution-formulas are also of early vintage, and they still represent basic concepts in the comprehension of formula construction. To be familiar with *any* new product presented by the milk industry for infant feeding it is essential to understand the basic principles of cows' milk

mixtures. With the physician's technical and scientific preparation in the fundamentals of nutrition, *he* is best able to comprehend the variants of these principles rather than having them "sold" by the lay representatives of commercial firms. The latter are sincere and forthright in fulfilling their missions but have had most of their training in sales and marketing rather than in the physiological and chemical background which constitutes the physicians' training. To rely entirely on the information purveyed by sales representatives or advertising media is to vaunt the experience and clinical knowledge which is the medically-trained physician's heritage.

Cows' milk dilution mixtures, in addition to being basic to the understanding of infant feeding also lend themselves to individual and versatile *adaption of a given milk food mixture to the infant*, rather than of *adjusting the infant to a fixed dilution*, no matter how nutritionally complete or synthetically-like human milk the preparation may be said to be. Because an understanding of milk dilutions is most simple (see Chaps. 2 and 4) and since the gastronomic extremes of the infant digestion are most tolerant, it would seem essential that the physician in infant feeding becomes acquainted with the technique of constructing and using milk mixtures consisting of cows' milk bases, with or without a CHO additive. A practical reason in addition, would be that of economy (see Appendix pp. 251) in the prescribing of less expensive formulas despite the average parent's disregard of monetary values in relation to the "heir apparent," especially in the present inflationary era.

### I. (A) EVAPORATED MILK

Evaporated milk represents one of the most widely-accepted and versatile bases of infant formula preparation. Earlier than 35 years ago, only a few physicians here and there used evaporated milk for infant feeding. After the fundamental work of Brenne-  
mann in Chicago and Marriott in St. Louis, from 1925 to 1935, the use of this type of milk rapidly became popular, until at the present time it is used widely as a basis for the infant milk dietary. Vast clinical experience in recent years has confirmed the work of earlier observers, until at the present it is easily the universal basic milk of choice. The former prejudices of "canned" milk have

TABLE 16

I (A) EVAPORATED MILKS

Name of Product	Fat % (Not Reconstituted)	Protein % (Not Reconstituted)	CHO % (Not Reconstituted)	Dry or Liquid	Calories per oz. (Not Reconstituted)	Tabls. per Oz.	Added Vitamins or Minerals per 13 oz. can	Curd Tension (Grams)	Affected by Terminal Sterilization (Yes or No)	How Formulated or Reconstituted	Chemical Definition and Essential Clinical Uses
Evaporated Milk (27 companies; 135 plants; over 200 brands)	7.9	6.8	9.7	L	44	1.79	400 I.U. Vitamin D	zero	No, except slight browning color	Equal amount of water added will reconstitute to equivalent of whole milk. In formulating—av- erage beginning dilu- tion is 1 oz. per lb. of body weight. CHO mod- ifier may be added which is usual procedure.	<p>A sterilized, homogenized, sweet cows' milk, evaporated to one half its volume or to such a point that it contains not less than 25.9% total milk solids.</p> <p>The manufacture of evaporated milk is regulated by the Food and Drug Defini- tion and Standard and thus uniform minimum content is assured, no matter which brand is used for infant feeding.</p> <p>Because of the physical change oc- curring in the curd due to the evaporat- ing and sterilizing process, the curd ten- sion and curd particle size are equal to that of human breast milk.</p> <p>The allergenic properties of evapo- rated milk are markedly diminished be- cause the soluble proteins (lactalbumin and lactoglobulin) are largely coagu- lated by the heat treatment during sterilization, and therefore evaporated milk offers a suitable hypo-allergic milk where cows' milk protein sensitization exists.</p>

been fortunately overcome, and the many qualities of this type of milk lend it safely to the most selective of infant digestive tracts.

The various virtues evaporated milk enjoys are the following:

*Uniform Composition.* Wherever evaporated milk is obtained, if made in the U.S., it will be found to contain the same percentages of fat and nonfat solids demanded by the Federal Government requirement of standard composition.

*Low Curd Tension.* The heat treatment given evaporated milk alters the physical and chemical properties of the protein molecule. The processing lowers the curd tension (zero) as well as reduces the curd particle size. This predisposes in the infant stomach to the formation of soft, small, flocculent casein curd equal to that of human milk in curd quality.

*Homogenization.* This process produces small fat globules, presenting a larger surface to the digesting enzymes. It also aids in some way toward the formation of a soft, fine curd and effects a uniform dispersion of the fat particles throughout the milk.

*Sterilization.* This step insures safety and convenience, and freedom from bacterial contamination until the can is opened. Thus the milk in the closed can may be kept an indefinite period of time which facilitates its distribution to all parts of the world, and its uniformity, convenience, and availability is assured as a constant infant food.

*Vitamin D Content.* The inclusion of 400 units of vitamin D in each 13 oz. can of evaporated milk assures a considerable margin of protection against avitaminosis D, a clinical entity so common 20 and more years ago but which now is almost rare in most American children. Weech states: "The opinion seems justified that this almost universal fortification of evaporated milk has done more than anything else to eradicate rickets in the very segments of the population least liable to avail itself of what we may call the newer knowledge of nutrition" (179).

*Hypoallergenic Properties.* This is brought about by the coagulation of the lactalbumin and lactoglobulin (soluble whey proteins) in the sterilization heat process, resulting in the retention of the whey protein with the casein in the intestinal tract during protein digestion. In this state they are less likely, than soluble protein, to be absorbed before being altered by digestive

action. This lessens considerably the allergenic hazard of milk allergy when evaporated milk is used.

In a study of the anaphylactogenic properties of various milks (129), Ratner stated that the reduction in the antigenic properties of evaporated milk when fed by mouth, is due to the fact that coagulation delays the passage of proteins through the gastrointestinal tract, making for more complete digestion, and diminishes the probability of the absorption of native antigens through the intestinal wall. He concluded that evaporated milk is the modification of greatest value for the person who is proven sensitive to milk.

Ratner in later extensive studies (128) in protein sensitivity tests found that heat-denatured milk (of which evaporated milk is the best known) can be fed safely to individuals allergic to cows' milk unless they are extraordinarily sensitive to the heat-stable *alpha-casein*.

Fries in an extensive bibliography (57, 60, 61) concludes that in an attempt to maintain optimum nutrition, mammalian-derived milks should be used wherever possible in preference to other protein sources; that evaporated milk during its sterilization and evaporation processing alters or denatures the lactalbumin fraction rendering it relatively non-antigenic.

*General Acceptance and Wide-spread Use.* Evaporated milk remains the milk base for infant formula mixtures more than any other milk food. It is doubtful that this is because it reflects the early training of most older practicing physicians when evaporated milk was the food used by Brennemann and Marriott in their curd tension studies in the 1920's when many had their training. More effective are the reasons given above which consummate all that is to be desired in a satisfactory base for formula construction.

### **Evaporated Milk in Hospital Nursery House Formulas**

The most critical evaluation of any bottle-fed food for infant consumption would be the one used by the physicians who have in their keeping the security and early nutrition of neonates, i.e. in the newborn nursery. In a survey of 64% of hospital nurseries with annual births of over 300 per year (1,904 hospitals) and

involving more than 2¼ million newborn infants in 1956 (110) it was found that 79.9% (1½ million infants) of the house formulas used in these hospitals was some dilution of evaporated milk. No evaporated milks were furnished gratis for this purpose despite the fact that other products were provided free of charge to any hospital wishing to avail themselves of the gratuity, and which in a year in a nursery with 50 bassinets would total about \$3000. In a similar study made in 1946 (135) it was found that 73.4% of hospitals used evaporated milk dilutions for the house formulas, which indicates that evaporated milk still remains the choice for this important purpose even after 10 years.

When the content of a food mixture is based on a sound respect for known nutritional principles, and has been successful over a long period of time in any specific nursery, that mixture would establish its status without further trial and error. By "successful" is implied the minimum number of gastrointestinal disturbances, adequate hydration and electrolyte balance, and sufficient caloric content to provide gain in weight.

Those who have had the responsibility of large or small groups of newborn infants in a nursery appreciate in full the many unhappy experiences which may befall them in even the most efficiently organized nursery. Clinical experience makes the physician in charge wary of the many unpredictable accidents that may occur, and will dictate caution in the choice of a milk mixture. This selection must be as dependable and "fool-proof" as possible, commensurate with the physician's concept of responsibility. For these reasons it would seem that a survey compiling the house formula most widely used would offer better guidance and credence when tabulated in a study, than some approach not accompanied by the hazards of the feeding of newborn infants in a hospital nursery.

It is also well known that the most commonly used milk mixture in private practice for the average normal bottle-fed infant has evaporated milk as the base of the dilution. It is indeed doubtful that this practice is a tangible factor only in the early training of the physicians who use evaporated milk so extensively. Habit prescribing or loyalties to the theories and teachings of a former esteemed and honored mentor would not outweigh the critical

judgment and experience of physicians who are ever observant of their successes and results of their own feeding procedures.

### **Are There Differences in Brands of Evaporated Milk?**

The manufacture of evaporated milk is carefully regulated by several agencies to insure a safe and constant product. First, it is controlled by the Food and Drug Administration by a Definition and Standard of Identity which specifies the fat, vitamin D, and solids content; exacting labeling instructions; and that it must be sealed in a container and processed by heat so as to prevent spoilage (174). Second, evaporated milk is further regulated by a Sanitary Standards Code by the Evaporated Milk Industry (53) which specifies rigidly the origin of the milk supply at the dairy farm level; its transportation to the plant; tests for quality and bacteriological cleanliness of the raw milk; standards for plant equipment, operation and its personnel; and specifications for the final product. There are four acceptable well known methods for the manufacture of evaporated milk, any of which may be used by the various plants. There have been no *nutritional* differences demonstrated in the milks from these various methods of manufacture. (*See last paragraph of this section on evaporated milk.*)

It may be said that the Federal Food and Drug Administration has more authority over evaporated milk supplies than the United States Public Health Service has over Grade A milk. The former agency may confiscate and bring legal action against evaporated milk processing companies failing to meet the Standard of Identity, while the latter agency only has the power to recommend to local health departments for bottled fluid milk the procedures which will result in a more complete compliance to city government ordinances. Some states have duplicated by legislation the Sanitary Standards Code originated by the Evaporated Milk Industry to provide a more constant and better product.

It is not known at any given time exactly how many brands of evaporated milk are extant, since various processing plants may affix an individual label of any store wishing to buy a specified volume of milk, and thus the numbers of wholesale and retail brands will vary as to specifically-labeled products. However, a conservative estimate would be over 200 brand names.

It is an accepted fact that many farmers collecting milk from as many herds made up of many "well-adjusted" or "unhappy" cows of mixed gencalogy contribute varied amounts of milk to a given collecting plant, and that this supply of milk is then pooled before processing. The exact techniques of sterilization and evaporation are not secret or patented and the various methods of accomplishing this are well-known to the entire evaporated milk industry. There are no studies in the scientific literature known to the author which advocate one technic of processing evaporated milk over another for a better nutritional end product. Certainly there are no studies extant where one processing method is superior to another which the infant gut could discriminate by digestion or absorption.

Because 21 companies in 135 plants presently process evaporated milk in the United States, it is logical to assume, with the regulation of the authoritative agencies mentioned previously, that brands of evaporated milk are nutritionally similar for infant feeding. A special precaution for the prescribing physician would be to note if a particular brand has been recommended on the label as suitable for infant feeding, in which case he can be certain that it is a product which he could safely endorse.

For a physician to prefer one brand of evaporated milk over another because of reputedly easier acceptance or digestion by the infant is a purely clinical impression only, or it places him in the position of having to prove by controlled studies the scientific reasons for his prescribing precision. It is well-known that some doctors specify a certain brand of evaporated milk for a formula mixture for one week and another particular brand to alternate for the following week. Another variation is to vary the brands from day to day "to get the baby used to many different kinds of milk." This is a form of prescribing erudition not substantiated by any scientific or even proven clinical evidence, and it places the physician's decision in the realm of the *art* of infant feeding—a sadly over-exploited phase of physician behavior. In his own practice, when asked which brand of evaporated milk he recommends, the author admits to making no specification unless pressed to do so and then the answer is usually "the least expensive" or "the one most readily available." If a specific brand

is asked about it is endorsed without question but with no qualifications as to its particular merits over any other brand. In a severely critical evaluation of his own feeding experiences, the author has noted no clinical differences in purity, acceptability, tolerance or digestive superiority by any infant as to which of the many brands are used for infant feeding mixtures. Every physician has the same privilege to make his own decision for whatever reason he may have. No infant will be demonstratively affected whichever his choice might be.

### I. (B) BOTTLED FLUID MILKS

Most of these bottled fluid milks are available in any community in the United States and Canada, but a few are known as *dairy specialties* which are special products only available in cities of a hundred thousand or more population. All are valuable adjuncts to infant feeding practices and take their place as time-honored and basic milk dilutions for infants, as well as the entire milk intake of older infants in the first year after the physician has deemed it practicable to graduate from the formula to whole milk. The time to transfer to whole milk from any formula mixture will vary widely as discussed elsewhere (page 183), and might be from the third to the twelfth month, no exact nutritional or scientific criteria being respected by any teaching dogma.

It is interesting to contemplate that no more than thirty years ago, most city and county health units were assiduously checking the bacterial count and the fat percentage of all dairy milk products, as required by standards legally enforceable in any given community. Only 50 years ago, dairy companies were actively opposing pasteurizing and bottling of milk. In sharp contrast to present practice, only rarely is a dairy found where authority is needed to establish a clean milk product. The maximum bacterial count permitted by most health units is 30,000 per cc. In the present day, most dairies average less than 4,000 per cc.—a happy commentary on modern sanitation and education.

**Whole Pasteurized Milk and Homogenized Vitamin D Milk** long have been used in infant feeding, and either forms a basic mixture together with a diluent and a carbohydrate. It is well

tolerated by most infants, it is inexpensive, and almost always available in civilized communities.

In 1930 to 1935, Grulee and Sanford observed 5,000 infants in the stations of the Infant Welfare Society of Chicago. The standard formula was cow's milk, water, and cane sugar, and the only variation permitted by the station physician was that of manipulating the proportions and total quantities. Ninety-two per cent of these infants progressed optimally as to weight gain and bone development as shown by monthly check-ups. Only 8 per cent of these babies were sent elsewhere for foods which their tolerance demanded. This remarkable study vindicates simple milk mixtures as adequate food sources for most babies.

Boiling (steaming for three minutes at the boiling point) the milk is required, since it is one of the prime methods by which the curd is physically altered so that a lower curd tension is obtained in the infant stomach. The boiling of milk is not so necessary in this day for sterilization as it was formerly, but it is wise at all times to also insure the sterility of milk by this safe and simple procedure.

It should be added here that most of all fresh milks distributed by dairies are now fortified with vitamin D, added directly to the milk by the dairy in the bottling plant. This is not to be confused with a former, but now outmoded method of increasing the vitamin D content—by feeding the vitamin D to the cows. Because of the variability of the vitamin D content of the latter, the more controlled method is now in general use. As has been said elsewhere (page 93), any child ingesting one quart of milk will receive 400 I.U. of vitamin D, and this is contributory for normal protection against rickets and optimum calcium and phosphorus utilization.

**Raw Certified<sup>®</sup> Cows' Milk** is available where Medical Dairy Specialties are found and also in dairies of some large cities. It is not as much in demand as at one time. Here no change is made in the milk, but it is produced almost aseptically and remains comparatively sterile until received by the consumer (500 cells per cc.). With other sources of clean milk available, the need for this product is obviously not so great as when most milks were under suspicion as to origin and cleanliness. It is formulated and boiled as is whole milk.

TABLE 17  
I (B) BOTTLED FLUID MILKS  
(Data furnished by Medical Dairy Specialties, Chicago except as indicated\*)

Name of Product	Fat %	Calories (per oz.)	Added Vitamins or Minerals (per qt.)	Curd Tension (grams)	Affected by Terminal Sterilization	Bacterial Count (max. permitted per cc.)	Chemical or Biological Definition and Clinical Uses
1. Homogenized Vitamin D Milk	3.4	19.5	400 D	20	Slight lowering; Slight vit. loss B <sub>6</sub> ; B <sub>12</sub> , C	30,000 average 4000	Whole pasteurized cows' milk, fat homogenized and with added irradiated ergosterol. <i>Average content: Protein 3.4%; CHO 4.7%; Minerals</i> <i>0.75%.</i> <i>Formulated by use of 1½ oz. milk per lb. body wt. with</i> <i>addition of a CHO modifier (see Chapt. 2).</i>
2. Raw Certified® Cows' Milk	4.0	20.3	400 D	40-60	Slight lowering; sl. loss of vit. B <sub>6</sub> ; B <sub>12</sub> , C	500	Raw milk produced under supervised and rigidly speci- fied sanitary conditions. <i>Formulated as with average cows' milk.</i>
3. Certified® Goats' Milk	3.5	19.7	—	20	(as above)	500	Hypo-allergenic milk in fresh form for use where sensi- tivity exists to cows' milk lactalbumin. <i>Formulated as with average whole cows' milk.</i>
4. Fat Free Milk (Skimmed)	0.2	10.6	2000 A 400 D	40-50	(as above)	500	Made by separating 4% butterfat Certified Milk and adding the vitamins at the end of pasteurization so as not to lose the vitamin A in the fat fraction. <i>Formulated as with average whole cows' milk.</i>
5. High Fat Milk*	4.5	21	400 D	40	(as above)	30,000	A high fat content milk where increased calories in cream is desired. <i>Formulated as with average whole cows' milk.</i>
6. Buttermilk	2.0	15.3	—	"soft"	Yes—milk will curdle	400,000,000	Milk cultured with pure <i>Strept. Lactis</i> culture which converts 1% of the lactose into lactic acid. <i>Formulated as with average whole cows' milk.</i>

TABLE 17—Continued

Name of Product	Fat %	Calories (per oz.)	Added Vitamins or Minerals (per qt.)	Curd Tension (grams)	Affected by Terminal Sterilization	Bacterial Count (max. permitted per c.c.)	Chemical or Biological Definition and Clinical Uses
7. <b>Enzylac</b> Homogenized Milk	3.5	19.7	400 D	12-15	Yes—residual enzymes destroyed; slight loss of vitamins B <sub>6</sub> ; B <sub>12</sub> ; C	30,000 average 4000	Pancreatic proteolytic enzymes crack protein molecules obtaining easily digested protein; reduced curd tension; residual enzymes in the milk that act as booster to pa- tients' digestive system. <i>Formulated as with average whole cows' milk.</i>
8. <b>Enzylac</b> <sup>®</sup> Fat Free milk (Skimmed)	0.2	10.6	2000 A 400 D	18-20	Yes—residual enzymes destroyed; slight vitamin loss B <sub>6</sub> ; B <sub>12</sub> ; C	30,000 average 4000	<i>Same as (7)-Enzylac<sup>®</sup> Homogenized Milk. Formulated as with average whole cows' milk.</i>
9. <b>Soft Curd</b> <sup>®</sup> Milk	3.5	19.7	400 D	Zero	Yes—slight vitamin loss—B <sub>6</sub> ; B <sub>12</sub> ; C	30,000 average 4000	Mineral modified by base exchange method. Calcium phosphorus reduced about 20% and replaced with Sodium to reduce curd tension. <i>Formulated as with average whole cows' milk.</i>
10. <b>L. Acidophilus</b> Milk "Kazol" <sup>®</sup>	2.0	15.3	—	"soft"	Yes—acidophilus organism destroyed, milk will curdle	500,000,000 plus	L. Acidophilus culture concentrate added to buttermilk making a palatable acidophilus milk designed to change intestinal flora from putrefactive to fermentative type. <i>Formulated as with average whole cows' milk.</i>
11. <b>Lo-Sodium</b> <sup>®</sup> Milk	3.5	17.7	400 D	15	Yes, lowering of curd tension, sl. vitamin loss	30,000 average 4000	An ion exchange process in which 90% of the Sodium is re- placed by potassium and calcium. <i>Formulated as with average whole cows' milk.</i>
12. <b>HI-PRO-tein Milk</b> <sup>*</sup> Glenora Dairy, Evanston, Ill.	2.0	16.5	2500 A 400 D	"Not known"	No	3000	Usually procured from Guernsey milk which is higher in protein, fat and solids than other milk. The fat is reduced from 4.8 to 2% and vitamin A and D added. <i>Children are said to drink more of this milk because of the reduced fat, and get more protein and calcium.</i>

**Certified® Goats' milk** may be obtained from the Medical Dairy Specialties but it is also found as a pasteurized product in other dairies in many cities. It is used primarily where it is suspected that there is a sensitization to the lactalbumin fraction of cows' milk in infantile eczema or other demonstrable allergic states. It is formulated as with whole cows' milk and its chemical composition in detail may be found in Tables (6, 34, 35, 36).

In some communities where there live the first generation émigrés from other parts of the world who are familiar provincially with goats' milk—the idea still persists that some mysterious value is inherent in the milk of this small ruminant, and that children fare better and are much “stronger” because of its use. No scientific data exist for this bit of folklore and no particular “strength” is associated by the use of goats' milk except possibly the odor of this product, or the breath, urine, and perspiration of the child who drinks it.

There is some evidence that goats are not susceptible to tuberculosis and thus bone and joint tuberculosis, as may occur from milk of bovine origin, is not as easily contracted. In this day of tuberculin-tested cattle which supply the milk sheds of our communities, this is not a pertinent point. Goats' milk fed exclusively is said to produce a macrocytic anemia, but this fact is lacking acceptable confirmation.

**Fat-Free or Skimmed Milk** may be obtained in the liquid bottled state from any dairy and is used where a lowered fat content is indicated. Because vitamins A and D are contained in the fat fraction, these should be supplemented even and if they are often added back to the milk after skimming. This product is perhaps most valuable where whole milk is being used by an infant without dilution, and perhaps during a minor bout of diarrhea or vomiting it would be wise to delete the fat temporarily. It is also useful in overweight or obese older children who may drink as much as they wish under other calorie restrictions, since the mineral content is retained and if vitamins A and D are replaced.

**High Fat Milk** is usually carried as a specialty product by most dairies. Its need in infant feeding is dubious but it is often prescribed by physicians or asked for by parents where an additional

source of calories is desired for older children. It contains about 1% more fat than the usual 3.4% of regular milk. In a distant day in the past when the fat content of milks for general usage was not specified, or perhaps was vitiated by the unethical dairy man, it probably was an advantage to assure the consumer of an adequate butter fat by specifying a premium milk.

**Buttermilk** is found antiquated by the newer and more easily controlled powdered lactic acid milks and the lactic acid-added cows' milk mixtures. Originally this was its empiric purpose in the role of lessening the curd tension. Another quality for which it is still extolled is in the pure culture buttermilk where the intestinal flora may be changed from a putrefactive to a fermentative one in the infant intestine. (See page 104.)

**Enzylac<sup>®</sup> Homogenized Milk** is a product of the Medical Dairy Specialties of Chicago and at this time (1959) is available in Chicago, Milwaukee, Madison, Wis., Detroit, Grand Rapids, Mich., Buffalo, Miami, Fla., Los Angeles and Phoenix, Ariz., and may be franchised to any dairy in the country to distribute. Basically it is produced by the addition of a pancreatic and "proteolytic" enzyme (169) to whole milk by a patented process, and results in softening of the curd of whole cows' milk as one of the variations of making the curd of milk more flocculent. The "proteolytic" effect and claim of "cracking the protein molecule" by the enzyme for better digestion of the protein is seriously questioned in a report of the Committee on Nutrition of the American Academy of Pediatrics (31).

**Enzycaps** are also produced by the Medical Dairy Specialties which is a capsule when used in one quart of milk produces the equivalent of one quart of fresh *Enzylac<sup>®</sup> Milk*. They are available through the dairies producing fresh *Enzylac<sup>®</sup> Milk* and are soon to be made available by drug store and physician distribution throughout the country.

**Fat Free Enzylac<sup>®</sup> (Skimmed) Milk** is the same as *Enzylac<sup>®</sup> Milk* except that the fat is reduced to 0.2%. Its content and use is as in *Enzylac<sup>®</sup> Milk* with the fat removed and for those specific indications. Vitamins A and D are added back since these fat soluble nutrients are removed in the skimming process.

**Soft Curd Milk<sup>®</sup>** is a mineral modified milk by base exchange

method and which is another technic of making the curd of cows' milk more flocculent ("zero" curd tension). This milk, as well as all of the others mentioned in this category, are formulated by adding a diluent and with or without a CHO modifier as with whole cows' milk. A frequent clinical use of *Soft Curd*<sup>®</sup> Milk is as a transition from any given infant milk formula over to whole unboiled cows' milk when the time comes in the first year to make this change.

**L. Acidophilus Milk** ("Kazol<sup>®</sup>" Medical Dairy Specialty) illustrates the recent interest noted in the literature in bacterial flora after a lapse of 25 to 30 years when the subject also was popular (141) (63) (69). In an effort to simulate the acid reaction and fermentative flora of the breast-fed infant stool, in contrast to the putrefactive flora of the bottle-fed infant stool, a culture of *L. acidophilus* is added to buttermilk to bring about this change in the flora. The milk is diluted and formulated as with any whole cows' milk.

**Cams** (Concentrated Acidophilus Milk Solids—Medical Dairy Specialty) is a culture of *L. acidophilus* organisms which permits a variation of dosage when added to buttermilk or whole cows' milk to produce the above described change of intestinal flora.

**Lo-Sodium**<sup>®</sup> Milk as its name implies is low in sodium which has almost wholly (90%) been replaced by potassium and calcium. There are few indications in infant feeding where sodium must be reduced to this extent for any clinical or organic entity, but it remains available for the older child should such indications be present.

**"HI-PRO-tein"** Milk is a specialty of a local dairy but exemplifies a unique principle of milk ingestion for the older infant and child. The name is a misnomer since the protein is only 3.7% when the usual percentage is 3.4%. The essential change is the reduction of fat to 2.0% of milk of Guernsey herds, and thus the relationship of protein to fat is higher. In theory as well as in practice the child drinks more milk because of the reduction of fat without affecting the flavor, and yet the calcium and protein needs are well-served because more of these two essentials are ingested in the larger quantity of milk consumed.

TABLE 18

## I (C) WHOLE MILKS—CANNED (LIQUID OR DRY)

Name of Product	Fat % (Reconstituted)	Protein % (Reconstituted)	CHO % (Reconstituted)	Dry or Liquid	Calories per Oz. (Recon- stituted)	Tabls. per Oz.	Added Vitamins or Minerals (per qt.)	Curd Tension (Grams)	Affected by Terminal Sterilization (Yes or No)	How Formulated or Reconstituted	Chemical Definition and Essential Clinical Uses
1. Concentrated Whole Milk (Cow & Gate) "Farmers Wife #1"	8.0	6.9 (not reconstituted)	9.6	L	45 (not recon- stituted)	—	800 D per pint	zero	No	As with evaporated milk (1 oz. per lb. of body wt.).	Lower fat, higher protein evaporated milk. Ideal for infant feeding.
2. Dryco (Borden)	1.5	4.0	5.7	D	16	3 $\frac{3}{4}$	2500 A B <sub>1</sub> 145 D 400 Ca 0.13 mg. P 0.10 mg.	zero	No	1 tbls. per 2 oz. water.	High protein low fat pow- dered milk. Its formula flexibility designed for wide- spread use in formula feed- ing. CHO may be added.
3. Foremost Instant Whole Milk (Foremost Dairies)	3.5	3.3	4.6	D	20	4	400 D	0-5	No	1 volume of powder to 3 volumes of water.	Use as and in place of fresh whole milk.
4. Foremost Sterile Whole Milk (Foremost Dairies) (Replaces "Mell-O-Milk")	3.25	3.4	4.8	L	20	2	400 D	0-5	No	As with whole cows' milk (1 $\frac{1}{2}$ oz. per lb. body wt.).	Use as and in place of fresh bottled whole milk.
5. Klim (Borden)	3.3	3.2	4.5	D	18	3 $\frac{1}{2}$	400 D	zero	No	1 packed tbls. per 2 oz. water.	Made from removing the water from fresh whole cows' milk with added vita- min. When reconstituted with water contains nutri- tive value of cows' milk and is used as such for all pur- poses.
6. Powdered Whole Milk (Cow & Gate)	3.4	3.3	4.7	D	18.3	approx. 3 $\frac{1}{2}$	800 D per pint	"not known"	No	1 level measure to 1 oz. water.	Powdered whole milk for routine use in normal infant feeding.
7. Varamel (Baker Laboratories)	3.0	2.5	4.3	L	16	—	2500 A 800 D 50 mg. C B <sub>1</sub> 0.6 mg. Niacin 5 mg. Iron 7.5 mg.	zero	No	Dilute with equal amount of water and add CHO to suit individual infant needs.	Concentrated Grade A milk in which the milk fat has been replaced by coco- nut and corn oils with the addition of vitamins and iron. No CHO has been added.

### I. (C) WHOLE MILKS—CANNED (Liquid and Dry)

These milks are essentially whole milk preparations, both liquid and dry, in stable form for infant feeding and other uses. Some were originally designed to make pure whole milk available in areas of the country or the world where clean reliable milk sources were not to be had for the feeding of infants, and have remained as favorites of physicians as important preparations in their infant feeding regimens. Some are of recent origin with the fat decreased or the animal fat replaced by vegetable fat for greater tolerance. Since they are either dry or liquid they would be evaporated or desiccated, either procedure of which renders the curd softer or more flocculent. To be reconstituted or formulated they are either made into whole milk by adding water and then formulated as whole cows' milk; or if they are liquid they are used as whole milk and diluted from there, or else treated as evaporated milk with 1 oz. per lb. of body weight, and water and a CHO added as is routine.

Their character and uses as well as formulation will be seen in the specific descriptions in Table 18 but several need special mention:

**Foremost Sterile Whole Milk** is a unique attempt to sterilize whole milk by a patented flash method so that the original taste of fresh milk is retained and yet sterility with safe-keeping as a pure milk will be maintained. This effort to accomplish both of these aims has been so successful it is said, that at present so great is the demand that production of this product has been limited to export only—to governmental agencies like embassies and consulates in far-flung outposts of the world and for the use of the armed services.

**Varamel** is different than any of the other members of this group in that the butter fat has been replaced by vegetable fat in Grade A milk and then evaporated, thus producing a product which has low, substituted fat together with a curd tension of zero due to the evaporation. It is different than any One-Formula Milk in that no CHO has been added, and it is thus formulated by the physician in the addition of the diluent, and a CHO as required.

## II. ONE-FORMULA (READY-MODIFIED) MIXTURES

The quest for a one, completely-universal kind of "synthetic" human milk is not new. It was the natural bent of the early nutritionists and chemists to use human milk as a standard and to attempt to make a pattern of it and to simulate the natural nutrient. If any one is under the delusion that our formidable array of 25 one-formula milks represents a modern deviation, he is reminded that as early as 1869 Biedert in Europe, then Rotel in 1878 in Philadelphia, and Miegs, all had this pre-eminently in mind. "Miegs' Mixture" was the counterpart of our present day armamentarium of single all-inclusive foods for babies. Then came *Whey Reduced Milk* of Friedenthal, *Whey Adapted Milk* of Schloss, and finally *Synthetic Milk Adapted* of Gerstenberger in 1915 bringing us close to the modern era, the latter being the present-day proprietary-named milk, S.M.A. So far the struggle has been not unlike the quest for the creation of life from organic substances by early venturesome biologists, or the hope of creating gold from baser metals by the alchemists of old. Ingenious man has come closer to success in his venture of an *ersatz human milk* than did his predecessors in the other fields mentioned.

The present-day one-formula mixture is no longer an attempt to duplicate nature, in fact, doubts have been cast recently on whether human milk is really "the perfect nutrient" just because Nature provides it for the human young (80). With the increase of knowledge as to nutritional requirements, essential elements and specific nutrients, the modern infant deprived of human milk, may not be too badly off except in the emotional realms.

### II. (A) and (B) DRY AND LIQUID ONE-FORMULA MILKS

The products presented in Tables 19 and 20 can be considered together since they vary only in their physical state and that, except for 3 in the *Dry* and 4 in the *Liquid* categories, all of them have a counterpart in each type. As will be seen in their respective tables they vary in the amount and origin of the fat; differences in vitamin content; variations in the type and amount of CHO; small diversities in the essential elements; and minute alteration in the per cent of protein. All have a curd tension of 6 grams

TABLE 19

## II (A) ONE-FORMULA MIXTURES—DRY

Name of Product	Fat c/c (Reconstituted)	Protein c/c (Reconstituted)	CHO c/c	Dry or Liquid	Calories (per Oz. (Recon- stituted)	Tabls. per Oz.	Added Vitamins or Minerals (per qt.)	Curd Tension (Grams)	Affected by Terminal Sterilization (Yes or No)	How Formulated or Reconstituted	Chemical Definition and Essential Clinical Uses
1. Alacta <sup>*</sup> (Mead-Johnson)	1.5	4.1	5.8	D	15	3½	none added	4	No	1 tbs. per 2 oz. water.	Mixed skimmed and whole milks, useful whenever high protein low fat formula is in- dicated (as for prematures and other infants with low fat tolerances).
2. Baker's Modified Powdered Milk (Baker Laboratories)	3.3	2.2	7.0	D	20	3	2500 A 800 D 50 mg. C 0.6 Mg. B <sub>1</sub> 5 mg. Niacin & 7.5 mg. Iron	zero	No	1 tbs. per 2 oz. water.	Grade A cows' milk in which the milk fat has been replaced by coconut oil and corn oils, with the addition of CHO, vitamins and iron. For the first year of infant feed- ing; for prematures and full- term infants; for comple- menting and supplementing breast feeding.
3. Biolac <sup>®</sup> Powder (Borden)	2.8	2.8	7.0	D	20	—	2500 A 400 D C variable B <sub>1</sub> .85 mg. B <sub>2</sub> 2.0 mg.	zero	0	1 tbs. per 2 oz. water.	Available only for export.
4. Bremil <sup>*</sup> Powder	3.5	1.5	7.0	D	20	3½	A 2500 C 50 Mg. D 800 Thiamine 0.4 mg. Riboflavin 1.0 mg. Pyridoxine HC 19.4 mg. Iron 8.0 mg.	zero	No	1 tbs. per 2 oz. water	A completely modified milk in which nutritionally essential elements of cows' milk have been adjusted to supply the nutritional re- quirements of infants de- prived of human milk.
5. HI-PRO <sup>®</sup> (Jackson-Mitchell Laboratories)	1.5	4.6	5.7	D	14	3	none added	"not known"	No	1 tbs. per 3 oz. water.	A mixture of spray-dried, whole separated de-lactosed cows' milk. Permits high pro- tein feeding without an ex- cess of fat. Valuable in diar- rheas, Celiac syndrome, and in the feeding of premature infants.

TABLE 19—Continued

Name of Product	Fat % (Reconstituted)	Protein % (Reconstituted)	CHO % (Reconstituted)	Dry or Liquid	Calories per Oz. (Reconstituted)	Tabls. per Oz.	Added Vitamins or Minerals (per qt.)	Curd Tension (Grams)	Affected by Sterilization (Yes or No)	How Formulated or Reconstituted	Chemical Definition and Essential Clinical Uses
6. "Humanized" Milk (Cow & Gate)	3.3	1.9	6.5	D	18.4	?	800	"not known"	No	1 level measure to 1 oz. water.	A modified food for normal infants.
7. Lactum® Powder (Mead Johnson)	2.8	2.7	7.8	D	20	3½	500 D per 26 oz. (reconstituted)	"not known"	No	3½ tbsls. to 6 oz. water.	A dried whole milk and Dextri-Maltose® formula de- signed especially for full term infants. Also useful as sup- plementary or complemen- tary feeding for breast-fed infants.
8. Olac® Powder (Mead Johnson)	2.7	3.4	7.5	D	20	3½	3000 A 500 D (reconstituted)	"not known"	No	3½ tbsls. per 6 oz. water.	Contains non-fat milk, vegetable oil, and Dextri- Maltose® designed for full term infants and especially useful for underweight babies and premature infants.
9. Similac® Powder (Ross Laboratories)	3.4	1.7	6.7	D	20	4 (packed)	2500—vit. A 400—vit. D 50 mg.—vit. C Thiamine—0.65 mg. Riboflavin 1.0 mg. Niacin Equiv.—7.0 mg. Pyridoxine—155 mcgm	zero	No	1 level measure (in can) or 1 packed tbsls. to 2 oz. water	Modified cows' milk ap- proximating breast milk com- position—essentially free of butter fat—added corn, co- conut, olive oils, vitamins. For feeding full term infants prematures, breast milk sup- plementation.
10. SMA Concentrated® Powder (Wyeth)	3.5	1.5	7.0	D	20	4	5000—A Thiamine—0.67 mg. Riboflavin—1.0 mg. C—50 mg. D—400 Niacinamide 5.0 mg. Pyridoxine 0.4 mg. Iron—5 mg.	zero	No	1 level measure (in can) plus 1 oz. of boiled water.	A food formula for infants. Prepared from tuberculin tested cows' milk in which the fat is replaced by animal and vegetable fats with the addition of lecithin, milk sugar, vitamins and minerals.

Enfamil® Powder (Mead Johnson) —announced 9.15.59; F. 3.7 (veg. oil substituted); P. 1.5; CHO. 7; Ca P ratio 1.3/1; 20 cal. per fl. oz.; 12 vitamins added; "0" curd tension; formula-  
lated 1 meas. to 2 oz. water; "a clinically proved formula nearest to mother's milk in nutritional breadth and balance."  
Similac with Iron® (Ross Laboratories) —announced 8.31.59; content and formulation same as Similac® Powder but with 12 mg. ferrous iron per qt. of formula; "for maintenance of iron  
stores, prophylaxis against iron deficiency, support of the normal diet throughout the first year of life."

TABLE 20

## II (B) ONE-FORMULA MIXTURES—LIQUID

Name of Product	Fat c.c. (Reconstituted)	Protein c.c. (Reconstituted)	CHO c.c. (Reconstituted)	Dry or Liquid	Calories per Oz. (Recon- stituted)	Tabls. per Oz.	Added Vitamins or Minerals (per qt.)	Curd Tension (Grams)	Affected by Terminal Sterilization (Yes or No)	How Formulated or Reconstituted	Chemical Definition and Essential Clinical Uses
1. Baker's Modified Liquid Milk (Baker Laboratories)	3.3	2.2	7.0	L	20	—	A 2500 D 800 C 50 mg. B <sub>1</sub> 0.6 mg. Niacin 5 mg. Iron 7.5 mg.	zero	No	Dilute with an equal amount of water	Grade A cows' milk in which the milk fat has been replaced by coconut and corn oils, with the addition of CHO, vitamins and iron for the first year of infant feed- ing; for premature and full- term infants; for comple- menting and supplementing breast feeding.
2. Bremil <sup>®</sup> Liquid (Borden)	3.5	1.5	7.0	L	20	—	A 2500 C 50 mg. D 800 Thiamine 0.4 mg. Riboflavin 1.0 mg. Niacin 6.0 mg. Pyridoxine 0.4 mg. Minerals Ca:P ratio 1½:1	zero	No	One part with one part of water	A completely modified milk in which nutritionally essen- tial elements of cows' milk have been adjusted or al- tered to supply the nutri- tional requirements of in- fants deprived of human milk.
3. Carnalac (Carnation Milk Co.)	3.2	2.8	7.1	L	20	2	400 D <sub>3</sub>	2	No	One volume to one volume water	A ready-prepared evapo- rated milk infant formula consisting of Carnation Evapo- rated Milk with maltose- dextrin syrup added. Suit- able for premature and full- term infants and as a supple- mentary feeding for breast- fed infants.
4. Dalactum <sup>®</sup> (Mead Johnson)	1.3	2.7	11.1	L	20	—	490 D (approx.)	6	No	1 oz. to 1 oz. water	Modified low fat milk formula containing Dextrin- Maltose <sup>®</sup> for use when low fat feedings are indicated, as when tolerance is low in pre- maturity, fever, hot weather and convalescence.

Enfamil<sup>®</sup> Liquid (Mead Johnson) — (for description see counter-part dry product in Table 19, page 109. 20 calories per fl. oz. Formulated by adding 1 part of Liquid to 1 part of water.)  
Modilac (Gerber Products Co.) F 2.6 (reconstituted); P 2.6; CHO 7.7; Ca 800 mg. P 605 mg.; announced 10.5.59; 20 cal. per fl. oz.; 6 vitamins added; "D", curd tension; formulated —  
1 oz. per 1 oz. water; "processed by an improved method of sterilization for maximum retention of true milk flavor, color and nutritive values and is isocaloric with breast milk."  
Similac with Iron<sup>®</sup> Liquid (Ross Laboratories) — see description in Table 19; formulated by adding one volume Liquid to 1 volume water.

TABLE 20—Continued

Name of Product	Fat % (Reconstituted)	Protein % (Reconstituted)	CHD % (Reconstituted)	Dry or Liquid	Calories per Oz. (Recon- stituted)	Tabls. per Oz.	Added Vitamins or Minerals (per qt.)	Curd Tension (Grams)	Affected by Terminal Sterilization (Yes or No)	How Formulated or Reconstituted	Chemical Definition and Essential Clinical Uses
5. Eagle Brand Condensed <sup>®</sup> Milk (Borden) (not reconstituted)	10.1	9.18	60.6	L	100	—	none added	not known	Darkening of mixture due to caramelization	1 oz. to 10 or 20 oz. of water	<i>A sweetened condensed milk, not recommended by the manufacturer for infant feeding but included by the author because of its usefulness in special instances—such as post operative and parenteral malnutrition and for rapid weight gain. To be used for a short time only.</i>
6. Lactum <sup>®</sup> Liquid (Mead Johnson)	2.8	2.7	7.8	L	20	—	500 D per 13 oz. can	5	No	1 oz. to 1 oz. water	An evaporated milk and Dextri-Maltose <sup>®</sup> formula designed especially for full term infants. Also useful as supplementary or complementary feeding for breast-fed infants.
7. Olac <sup>®</sup> Liquid (Mead Johnson)	2.7	3.4	7.5	L	20	—	3000 A 500 D	4	No	1 oz. to 1 oz. water	Contains non-fat milk, vegetable oil and Dextri-Maltose <sup>®</sup> designed for full term infants and especially useful for underweight babies and prematures.
8. "Prepared Formula" "Farmer's Wife" (Cow & Gate)	4.0 (not reconstituted)	6.7	14.3 (not reconstituted)	L	38 (not reconstituted)	—	400 D per pt.	zero	No	Formulated as evaporated milk. No extra CHD needed	Half-skimmed evaporated milk with added CHD to be used in infant feeding with only water as a diluent.
9. Similac <sup>®</sup> Liquid (Ross Laboratories)	3.4	1.7	6.7	L	20	—	Vit. A—2500 Vit. D—400 Vit. C—50 mg. Thiamine—0.65 mg. Riboflavin—1.0 mg. Niacin Equiv.—7.0 mg. Pyridoxine—155 mcgm.	zero	No	One fluid oz. to one oz. water	Modified cows' milk approximating breast composition—essentially free of butter fat—added corn, coconut, olive oils—feeding full term infants, prematures, breast milk supplementation.
10. SMA <sup>®</sup> Concentrated Liquid (Wyeth)	3.5	1.5	7.0	L	20	—	A—5000 Thiamine 0.67 mg. Riboflavin 1.0 mg. C—50 mg. D—400 Pyridoxine—0.4 mg. Iron—5 mg.	zero	No	Contents of one can diluted with equal amount of boiled water to make 26 oz. of formula	Food formula for infants. Prepared from tuberculin-tested cows' milk in which the fat is replaced by animal and vegetable fats with the addition of lecithin, milk sugar, vitamins, and minerals. The mixture is homogenized and sterilized.

or less which digestive-wise is analogous to "Zero." The dry and liquid products of one company (*Baker Laboratories*) have the added qualification of "Grade A Milk" which other companies might have extolled. (See "Purity" of Milks, page 263.)

These products are important adjuncts to our infant feeding needs. They have in common the virtues of being easily prepared; good distribution which makes them easily available; the nutritional principles underlying their composition are well-documented and scientifically well-founded; well-fortified with vitamin D as with evaporated and bottled fluid milks; and their trade names are familiar to the buying public.

In addition to this it must be said that they have a fixed chemical state—they can be varied only as to quantity and degree of dilution without the mobility afforded by a mixture where the CHO may be varied for excess fermentation or to combat hard stools, and for the ease of increasing the calorie content if the need presents. The infant is made to fit the formula mixture rather than adjusting the food combination to the individual infant. It is true that human milk has this constancy and immobility but human milk has still something imperceptible which has not yet been secured in a container.

It is of interest to note that one of the new one-formula foods, *Carnalac* (Carnation Milk Co.), is being distributed through drug store as well as through grocery trade outlets on a sectional basis. All of the other 24 products listed in this group have usually been available through drug store distribution for reasons which the companies have frequently emphasized in their physician-contact advertising. It will be interesting to observe if any other manufacturer duplicates this policy of distribution initiated by the Carnation Milk Co. in this highly competitive field.

### **Liquid Versus Dry One-Formula Milks**

As was stated in the first paragraph of this section, 9 of the *Dry* One-Formula preparations have their identical (chemical) counterparts in a *Liquid* form. The reason for this is apparently *consumer demand* rather than some theoretical or scientific need. When one of the products listed converted to the *Liquid* form, the representative of that company made a special visit to the

author to announce this "important change" in the physical state of their product. When the author facetiously chided the field man as to why it was necessary, and that they were now "charging for water," he defended this procedure by some astounding and apparently true facts.

As is well known in the consumer market, surveys are constantly being conducted as to *consumer preference*, which runs the gamut of buying psychology. In relation to *Liquid* versus *Dry* One-Formula Milks the following incredible (*to the author*) facts were elicited:

a) the measuring of liquid preparations seemed easier since it was "not necessary to count *tablespoonfuls*";

b) the price of one 13-oz. can of a *Liquid* preparation was only 27¢ while the 1-lb. can of the *Dry* product cost 99¢, which "was so much more"; (*See Tables 49 & 51—Appendix—for retail costs of many products.*)

c) the stirring of the powder, although easily soluble, seemed "too much" when it could be had already dissolved;

d) there was also the admitted excuse that although the *Dry* infant food quantity lasted 4 or 5 days, it was an added incentive "to have an excuse to get out and go somewhere every day" and as long as the trip was for the baby, it was no hardship.

With these "cogent" reasons in the mind of the buyer, the manufacturer must capitulate, especially when the competition in the field already has done so.

### III. PREPARATIONS WITH SPECIAL FUNCTIONS

In this third category are found the milks or foods which are used for particular indications. When the human infant is denied the natural nutrient which was designed especially for the specific mammalian species to which it belongs, the abnormal follows closely on the heels of the normal, and it is difficult to discern where the normal ends and the pathological state begins. Where these digestive problems and specific needs are demonstrated, the nutrition laboratory, research sources, and ultimately the commercial infant food industry have identified and prepared preparations for these eventualities. Each sub-group of this III division are presented as to the clinical or pathological entity for which

they were designed, and a description of each of these food substitutes will be outlined.

### III. (A) PROTEIN MILKS

**Protein Milk** (syn.—Albumin Milk, Eiweiss Milch) was originally devised by Finkelstein, *et al.*, in 1906, and from that time through the present has enjoyed a universal reputation as an important infant dietary need. Its status as a unique therapeutic food remains unchallenged through the years. It was not too long ago that it was made laboriously in the home, with great difficulty attending its preparation. Now the powdered forms are so convenient and easily available that it is unnecessary to dwell on the procedure of its home preparation.

It is essentially *partially skimmed lactic acid milk to which has been added the curds from whole milk obtained by rennin digestion of whole cows' milk*. It has a low buffer value, a small amount of the fermentable lactose of cows' milk, little of the whey salts, and it is a poor culture medium for the fermentable bacteria. The high casein content favors the formation of formed stools, the curd is fine-grained, the mixture is acid, and the fat is low (2 per cent). All of these factors render it an ideal mixture for digestion.

Protein Milk is especially indicated for all of the serious diarrheas not due to some specific infection, such as dysentery. Of late years, it is especially used in the treatment of some of the intolerances which fall under the classification of the Celiac Syndrome.

Protein Milk is almost always used full strength (1 tbs. to 2 or 3 oz. of water) with at least 3 per cent CHO added. Some physicians omit the CHO at first in severe diarrheas, but gradually add it back until a level of 5 or 6 per cent is obtained. Under the protection of the Protein Milk, other foods may be added until all danger of frequent stools is gone. In fact the infant may be left on this food for an indefinite period of time, since it is as complete a food as any other milk. Certainly in the Celiac states it is maintained often for two years, with equable results.

Protein Milk is not to be confused with recent preparations of **Protein Supplements** (III (E) Table 25). These latter preparations are either mixtures of hydrolysates of protein containing the unit forms of the protein fractions (amino acids etc.), or are complex

TABLE 21

III (A) PROTEIN MILKS (ALBUMIN MILK) (EJWEISS MILCH)  
(Skimmed lactic acid milk added to the curds of rennin-digested whole cows' milk)

Name of Product	Fat %	Protein %	CHO %	Dry or Liquid	Calories per Oz. (Recon- stituted)	Tabls. per Oz.	Added Vitamins or Minerals (per qt.)	Curd Tension (Grams)	Affected by Terminal Sterilization (Yes or No)	How Formulated or Reconstituted	Chemical Definition and Essential Clinical Uses
1. Powdered Protein Milk <sup>a</sup> (Mead Johnson)	2.2	3.1	2.1	D	14	3½	none added	zero	No	4 packed tbs. to 11 oz. water (sample or beginning dilu- tion	Acidified high protein low lactose milk with modified curd, prepared by a modified Finkelstein method; espec- ially useful in diarrhea, celiac disease and syndrome, and for newborn infants.
2. Powdered Protein Milk (Cow & Gate)	1.6	3.2	2.6	D	11	?	800 I)	"not known"	No	1 measure to 1½ oz. water	Acid milk mixture as de- scribed by Finkelstein. Used effectively in the diarrheas of minor intolerances of fat and CHO, and in cystic fibrosis.
3. Protein SMA <sup>b</sup> Acidulated (Wyeth)	2.2	3.5	2.8	D	15	4	9000 A 600 I) Thiamine 0.67 mg. Ascorbic acid 50 mg. Iron 5 mg.	zero	Cannot be terminally sterilized.	4 level tbs. to make paste with part of water dilu- ent (9 oz.) warm water. Add re- mainder of water and stir.	A food prepared for pre- mature and other infants re- quiring a high protein in- take. It is an acidulated dried product derived from tu- berculin-tested cows' milk in which the fat is replaced by animal and vegetable fats with the addition of lemon juice, casein, vitamins and minerals.

extra sources of protein food where a total increased protein is indicated. Protein Milk is neither of these divisions of Protein Supplements. Its merit and use lies in the physiological role of the pre-digestion of the curd rather than in the chemical characteristics of its composition.

The author finds this milk indispensable in his infant feeding practice. It is ideal in the proven pathological states found in the fat and starch intolerances, or when normally well infants persist in having loose, fermentative, or abnormally frequent soft stools. When the accepted procedures of fat and CHO reduction in the usual formula fails to produce satisfactory results, a short or long period with Protein Milk is usually successful in inducing the desired state, and the infant can then be returned to the former mixture without mishap. Protein Milk is also used satisfactorily in diarrheas of parenteral origin after the original infection has spent its force or has been controlled.

It is known that the 3 companies: *Mead Johnson, Cow & Gate*, and *Wyeth*, each of which provide one such product, make no profit in the manufacture and distribution of their Protein Milks but actually lose income on their continued production. They deserve the esteem of the medical profession for this altruistic public service at the sacrifice of monetary gain.

### III. (B) ACID MILKS

Acid milk has gained its just popularity chiefly through the initiative of Marriott and his co-workers, who demonstrated that it had much the same therapeutic properties as buttermilk, the peculiar virtues of which had been recognized empirically for many years. It can be prepared either by culturing or souring fresh milk (culture of *Lactobacillus acidophilus*) or by adding an acid to the milk. Lactic acid was first used for this purpose, and has always been favored more extensively than any other method. Six cc. per liter or  $1\frac{1}{2}$  drams of 85 per cent U.S.P. lactic acid to the quart, which is equivalent to 4 or 5 drops to the ounce, is added to *cold*, boiled, whole cows' milk or evaporated milk very slowly, which forms very small, fine curds.

Other forms of acid milk have had their local proponents for

TABLE 22

## III (B) ACID MILKS

(The curd of whole bottled or evaporated milk softened with the addition of lactic acid)

Name of Product	Fat %	Protein %	CHO %	Dry or Liquid	Calories per Oz. (Recon- stituted)	Tabls. per Oz.	Added Vitamins or Minerals (per qt.)	Curd Tension (Grams)	Affected by Terminal Sterilization (Yes or No)	How Formulated or Reconstituted	Chemical Definition and Essential Clinical Uses
Lactic Acid Milk <sup>®</sup> with Dextro-Maltose <sup>®</sup> (Mead Johnson)	3.4	3.3	4.6	D	19	3½	none added	zero	No	1 tbs. to 2 oz. water	Digestible acidified whole milk useful especially for un- dernourished infants and those with digestive disorders.
Powdered Lactic Acid Milk—Partly Skimmed (Cow & Gate)	1.8	3.3	4.7	D	16	—	800 D	"not known"	No	1 level measure of powder to 1 oz. water	An acidified powdered partly skimmed milk. Used for high caloric feedings, to offset fer- mentative bowel disorders, in prematurity and in colic dis- ease.

short periods of time (18). Lemon juice, 6 drams to the quart of milk; orange juice, 2 ounces to the quart; pure citric acid, 4 grams ( $1\frac{1}{2}$  tsps.) to the quart of milk; acetic acid U.S.P. (36 per cent), 1 dram to a pint, or of cider vinegar, 1 ounce to the quart of milk; hydrochloric acid, 4 ounces of the decinormal solution to the pint of milk. All of these acids should be added slowly to cold milk with constant stirring, as with lactic acid. There is no striking difference, clinically, in the use of any of these acids. Dried lactic acid milks are the most convenient as well as the most efficient preparations of this type of milk, and are the ones most generally used at the present time. It should be remembered that lactic acid is a severe caustic when ingested in full strength and is a poison hazard to ambulant children.

Acid milk is much more readily digested than fluid bottled cows' milk so that it can be given in greater concentration and larger amounts without danger of causing a digestive disturbance. It can be given undiluted from the start. It is especially indicated in infants who are undernourished and need a relatively large amount of food, and in those who will take only a small amount at one time, or whose digestion is impaired or inadequate. The major factor in its greater digestibility lies in that, as with buttermilk, it does not recoagulate in the stomach or only to a minimal degree.

Other reasons for its greater tolerance are said to be the neutralization of the high buffer content of sweet milk through the addition of acid, and also that it counteracts the high percentage of calcium phosphate and casein in cows' milk which, in turn, neutralize so much of the HCl of the stomach that gastric digestion is inhibited. The importance of these claims is still somewhat in dispute. Other benefits better substantiated are that the degree of acidity so established inhibits bacterial growth; favors normal functioning of the pyloric sphincter; stimulates the flow of bile, pancreatic, and intestinal juices; and promotes the absorption of calcium. An added advantage is recognized in that a carbohydrate may be added to the acid milks in larger amounts than with sweet milk (even up to 7 per cent) and it is well tolerated—much more so than in conventional CHO proportions.

### III. (C) HYPO-ALLERGIC PREPARATIONS

In combating the various diatheses attributable to a sensitivity to various antigens present in a baby's environment, the role of food is an important one. Eczema is one of the main antagonists in infancy of the physician as is the asthmatic state also, but to a lesser degree. Since it has been shown that the allergenic factor is most often in the protein component of the infant's food, it is quite natural that extensive efforts have been made in this direction to solve the problem in the food of the infant. It is equally logical, then, that the protein should be changed or replaced as the first step in neutralizing the allergic effect:

#### a) By Substituting the Protein of Another Mammal

The protein molecule in the milk lactalbumin often is identified as the allergenic agent, and changing to the milk protein of another species than the cow is one way by which this sensitivity may be met. The goat is the only other domestic animal available for milk production in modern civilized countries, and hence there are several products of goats' milk available. Fresh goats' milk has already been discussed (see page 102).

#### b) By substituting a Protein of Vegetable Origin

Another method by which the protein molecule may be rendered non-allergenic to the sensitized child is by invading the vegetable kingdom for the protein factor of the milk. The soybean is the usual choice of this protein in some products, while almond protein in others. The formulas are adequate in fat and carbohydrate components, vitamins and minerals are added in some, and they provide a complete food adequate for normal growth.

#### c) By Heat Treatment of the Protein Fraction of Cows' Milk

By still another process, that of changing the structure of the protein molecule by heat treatment, milk is made less allergenic. This is also known as denaturing the protein. In the discussion of the thermal processing of cows' milk as it pertains to evaporated milk, more information of this technique and its effects will be found there and thus avoid repetition (see page 93).

III (C) HYPO-ALLERGIC PREPARATIONS (LIQUID AND DRY)  
(Products where the protein molecule of cows' milk has been substituted by another protein source, either vegetable, from another species of mammal, or by heat treatment of the protein)

Name of Product	Fat % (Reconstituted)	Protein % (Reconstituted)	CHO % (Reconstituted)	Dry or Liquid	Calories per Oz. (Recon- stituted)	Tabls. per Oz.	Added Vitamins or Minerals (per qt.)	Curd Tension (Grams)	Affected by Terminal Sterilization (Yes or No)	How Formulated or Reconstituted	Chemical Definition and Essential Clinical Uses
1. Allergiac (Cow & Gate)	2.0	3.3	5.4	D	15.4	—	none added	"not known"	Yes	1 level measure to 1 oz. water	For children allergic to cows' milk. <i>Lactalbumin has been dea- tured by heat and the milk acidi- fied with lactic acid.</i>
2. Dale <sup>*</sup> Dehydrated Goats' Milk (Cutter Lab.)	3.6	3.4	5.0	D	19	3	None added	"not available"	?	1 tbs. in 2 oz. water	Prepared from pasteurized fresh whole milk from selected herds. Spray dried and vac- uum packed. Recommended in cases of allergy or for spe- cial diets.
3. Gerber Concentrated Meat Base Formula (Gerber Products Co.)	3.1 (Reconstituted on a 13 oz. MBF: 19 oz. H <sub>2</sub> O)	2.7	7.0	L	21	2	403 D (reconstituted)	zero (non-milk)	Yes	Flexible—8:16 plus CHO to 13:19 plus CHO (Diluted with water and CHO modifier added)	A hypo-allergenic formula for infants and young children with allergy or other intoler- ance to milk. Provides high quality animal protein. En- riched with calcium.
4. Hypo-Allergic <sup>*</sup> Whole Milk Powder (Wyeth)	3.5	3.3	4.7	D	19.5	4	B <sub>2</sub> —4 meg.	zero	No	One packed tbs. to 2 oz. water	Milk prepared for individ- uals who exhibit allergic reac- tions because of hypersensi- tivity to ordinary cows' milk; fresh tuberculin-tested cows' milk is processed by prolonged thermal treatment and dried.
5. Meyenberg <sup>*</sup> Evapo- rated Goat Milk (Jackson-Mitchell)	3.8	3.1	3.5	L	20	—	none added	"not known"	No	Formulate as with evaporated cows' milk	Used in the feeding of pa- tients who are allergic to the lactalbumin of cows' milk. <i>Protein molecule is from an- other species.</i>
6. Meyenberg <sup>*</sup> Powdered Goat Milk (Jackson-Mitchell)	3.8	3.1	3.5	D	20	3	none added	"not known"	No	1 tbsp. to 2 oz. water	Used in the feeding of pa- tients who are allergic to the lactalbumin of cows' milk.
7. Mull-Soy <sup>*</sup> Liquid (Borden)	4.0	3.1	4.5	L	20	—	Minerals 1.0 Ca—0.13 P—0.11	zero	No	Dilute with equal volume with water and formulate as with evaporated milk - adding a CHO modifier if desired	Hypo-allergenic soy food for infants and children who are milk sensitive. Palatable and well-tolerated.
8. Mull Soy <sup>*</sup> Powder (Borden)	4.0	3.1	4.5	D	20	3 $\frac{3}{4}$	Minerals 0.7 Ca—0.13 P—0.11	zero	No	1 level tbsp. to 2 oz. water	Hypo-allergenic soy food for infants and children who are milk sensitive. Palatable and well tolerated.

TABLE 23—Continued

Name of Product	Fat % (Reconstituted)	Protein % (Reconstituted)	CHO % (Reconstituted)	Dry or Liquid	Calories per Oz. (Reconstituted)	Tabls. per Oz.	Added Vitamins or Minerals (per qt.)	Curd Tension (Grams)	Affected by Terminal Sterilization (Yes or No)	How Formulated or Reconstituted	Chemical Definition and Essential Clinical Uses
9. Nutramigen <sup>®</sup> (Mead Johnson)	2.7	2.2	8.5	D	20	3½	none added	zero	No	2 tbs. to 3 oz. water (infants); 1½ cups per qt. of water for children and adults	Protein hydrolysate formula for infants, sensitive to pro- teins in milk and other foods; designed also to maintain nu- trition during test or elimina- tion diets; and for tube feed- ing.
10. Sobee <sup>®</sup> Powder (Mead Johnson)	2.6	3.2	7.7	D	20	6	None added	zero	No	6 tbs. to 7 oz. water	Hypoallergenic balanced soya formula designed for infants actually or probably sensitive to milk, and as a diagnostic measure to confirm or rule out milk sensitivity.
11. Sobee <sup>®</sup> Liquid (Mead Johnson)	2.6	3.2	7.7	L	20	—	None added	zero	No	1 oz. per 1 oz. of water	Hypoallergenic balanced soya formula designed for infants actually or probably sensitive to milk, and as a diagnostic measure to confirm or rule out milk sensitivity.
12. Soyalac Infant Powder (Internat. Nutrition Lab.)	3.2	2.85	5.4	D	18	4	Ferrous Sulphate Calcium Carbonate Dibasic Calcium Phosphate	?	No	1 vol. milk to 7 vols. of water	Contains soya bean solids, dextrose, maltose, dextrins, sucrose, soya oil. A spray- dried soya food to serve the nutritional needs of the bottle- fed infant. Completely soluble and formulated to simulate human milk. Used for infants allergic to dairy milk.
13. Soyagen Infant Powder (Internat. Nutrition Lab.)	3.2	2.85	5.4	D	18	4	Ferrous Sulphate Calcium Carbonate Dibasic Calcium Phosphate	?	No	1 vol. milk to 7 vols. of water	Same as above but sold in grocery and health food stores. Product (11) and (13) only sold in drug stores.
14. Soyalac Infant Con- centrate (Internat. Nutrition Lab.)	4.0	2.05	6.0	L	20	—	B <sub>2</sub> —2 mcg. A—3000 D—400 Salt, Calcium glu- conate, calcium hy- droxide, ferrous sul- phate	?	No	1 can milk to 1 can water	Similar to Soyalac Infant Powder but in liquid form.

(Evaporated Milk, Fresh  
Bottled Goats' Milk and  
Hi-Pro<sup>®</sup> are also listed  
in this category of Hypo-  
allergenic Milks)

Kraybill, recently reported studies of how milk protein may be rendered less allergenic, in addition to thermal or heat treatment. By *gamma radiation* the ability of the milk to cause allergic symptoms is lowered but in so doing an undesirable flavor and odor occurs. A technique has been developed which essentially eliminates these undesirable changes. Milk treated by ultraviolet radiation also shows reduced power to cause allergic reactions but here again shows adverse changes in color, odor and flavor. (196)

### **Brief Résumé of Dealing with the Milk-sensitive Infant**

It is not within the scope of this book to discuss the very comprehensive subject of allergy and food sensitization. This is the place to mention briefly the total effect that the practitioner of infant feeding might expect from the array of foods available against allergic states (189). It has been a common pediatric experience of many physicians to have an eczema clear up rather promptly when a patient so affected receives one of the listed foods used for this purpose. However, within a week or more, most of the lesions may reappear with the same intensity. This experience can be repeated by ranging through the entire list. Bigler states that apparently the baby may be unfortunate enough to become sensitized to the new protein, changed as it might be, and demonstrate in the skin this sensitivity after a short time (17). It is one of the most disheartening phases of a pediatric practice, and it is difficult to determine how much the food is incriminated in contrast to the many other allergens to which the baby's environment exposes him.

A routine procedure to follow would be to offer the infant one or more of the foods designed for this purpose. Usually, most authorities admit, if the skin can be kept in a quiescent state with the aid of hypo-allergenic foods, the soothing and conventional ointments, and freedom from external irritants, the infant apparently loses his sensitivity gradually, and the lesions become subacute or even disappear spontaneously sometime in the second year. Those with more optimism and less critical appraisal may presume they have mastered the difficulty by their various pro-

cedures. The author is apparently more doubtful and analytical of the favorable results when success finally crowns his efforts. This skepticism is felt by many of those who have the same experiences, and is related here merely to help prevent the discouragement on the part of the physician who fails to note any startling improvement in the various eczematoid dermatoses which he must treat in his practice. (See also discussion of the gastrointestinal milk-sensitive infant on "Colic" in Chapter 10.)

### III. (D) FAT-FREE (SKIMMED) (NONFAT) MILKS

The products in this grouping have increased both in number and in type of preparation since the last listing in the previous book. In addition to the bottled fluid skimmed milks always available in dairies, there have appeared the *Evaporated Skimmed Milks* with the obvious advantage of curd softening due to the evaporation, and the "Instant" "Nonfat" Dry Milks which emphasize the rapid solubility and the inexpensiveness of reconstituting milk with remaining adequate protein and calcium inherent in whole cows' milk. Probably for apparent sales psychology the word "skimmed" appears to connote an unwanted impression and "nonfat" has been substituted as more desirable.

The technology of adding vitamins A and D, obviously removed with the animal fat, has not as yet been solved for dry skimmed milk preparations, and if used for a period of time for infant feeding, should be supplemented. The fat-soluble vitamin D has been replaced in the evaporated skimmed milks.

The problem of a *dried* skimmed milk preparation being used for infant formula mixtures arises as to the original product being sterile or remaining in such state from processor to the infant formula. The author is not aware of any recent studies on this question since the newer products have become available. From a practical viewpoint it would not be a serious problem for an individual infant but it might become a factor in making up "house formulas" or "stock mixtures" in a hospital or orphanage milk room.

These milks are obviously indicated where a fat-tolerance of a given baby exists, or for a matter of economy in feeding large

TABLE 24

## III (D) FAT-FREE (SKIMMED) MILKS (LIQUID AND DRY)

(MILKS with the fat component removed to various degrees, useful when the fat is a disturbing factor)

Name of Product	Fat % (Reconstituted)	Protein % (Reconstituted)	CHO % (Reconstituted)	Dry or Liquid	Calories per Oz. (Recon- stituted)	Tabls. per Oz.	Added Vitamins or Minerals (per qt.)	Curd Tension (Grams)	Affected by Terminal Sterilization (Yes or No)	How Formulated or Reconstituted	Chemical Definition and Essential Clinical Uses
1. Carnation Nonfat Dry Milk Solids (Carnation Milk Co.)	0.07	3.39	4.76	D	10.15	8	—	45-55	No	3.2 oz. per qt. ( <i>May then be formulated as with whole cows' milk</i> )	Spray dried nonfat dry- milk rendered instantly solu- ble by a process useful in vari- ous types of diarrhea, celiac syndrome, cystic fibrosis of the pancreas and for a reduced caloric intake.
2. Foremost Instant Nonfat Dry Milk (Foremost Dairies)	0.1	3.5	4.8	D	10	6	None	40	Yes, lowers curd tension	1½ cups or 3½ advp. oz. plus water to 1 qt. ( <i>May then formulate as with whole milk</i> )	Use in conditions where di- gestion is impaired; i.e., poor fat tolerance, simple diar- rheas, celiac syndrome.
3. Pet Instant Nonfat Dry Milk (Pet Milk Co.)	0.1	3.5	4.8	D	10.4	6½	None added	20	No	1½ cups powder in 3¾ cups water equals 1 qt. nonfat milk	A nonfat dry milk made from pasteurized, evaporated skim milk by a spray-drying process which retains all of the food values of the original high quality fluid nonfat milk. Used to fortify milk mixtures where increased levels of pro- tein and calcium, and lower fat are desirable; in disease states where digestion is tem- porarily impaired; and for higher solids formulas for in- fants with limited capacity or exceptional demands.
4. Sunshine Brand Skimmed Evaporated Milk (Defiance Milk Products Co.)	trace (not reconstituted)	8.17	11.49	L	24½ (not re- stituted)	—	400 D (per t3 oz. can)	zero	No	Use as evaporated milk—CHO may be added	Sweet whole milk from which butterfat has been removed prior to concentration and sterilization. Solids content (with exception of fat) is like evaporated milk, altho solids content is 10% greater than regular evaporated milk. Rec- ommended for various types of low fat diets.
5. Skimmed Concentrated Evaporated Milk "Farmer's Wife #3" (Cow & Gate)	2.0 (not reconstituted)	8.0	10.1	L	29 (not recon- stituted)	—	800 D (per pint)	zero	No	Formulate as with evaporated milk— CHO added if desired	Low fat—higher protein evaporated milk.
6. 50% Skimmed Concentrated Milk "Farmer's Wife #2" (Cow & Gate)	4.0 (not reconstituted)	6.9	9.6	L	32 (not recon- stituted)	—	800 D (per pint)	zero	No	Formulate as with evaporated milk— CHO added if desired	Half-skimmed evaporated milk. Has higher protein-fat ratio than ordinary evapo- rated milk.

groups of infants where the animal fat is not a required component. The largest field of usefulness served by these products is an economical way in which to provide the important constituents of milk for the older and growing child after infancy, i.e. the protein and calcium which obtains in whole milk.

### III. (E) PROTEIN SUPPLEMENTS

Six years ago when this category was outlined in the previous text there were 9 protein supplements available. At the present there are only 3 and all by *Mead Johnson & Co.* There apparently are fashions in nutrition research and in 1952 there was an enthusiasm for protein investigation which was reflected by the manufacturers in providing these products for a presumed widespread protein deficiency, the demand for which apparently did not materialize. Protein deficiency may develop because of an insufficient intake of protein food; when impaired digestion or absorption exists; in unusual loss of protein from the body; or when there is an increased breakdown of body tissue protein. These needs may be supplied by offering larger amounts of complex protein, or by supplying predigested protein broken down to primary states for ease of absorption with a minimum of digestion—the proteoses and amino acids.

**Casec<sup>®</sup>** (*Mead Johnson*) is a useful adjunct to infant feeding when the situation does not require radical remedial measures. It is essentially calcium caseinate made from the curd of skimmed milk and lime water. It contains 88% protein and is therefore a concentrated protein food. It is also a convenient form of calcium intake, containing 1.6% of this element. In addition to being a satisfactory protein supplement it is also an excellent addition to the milk mixture in the milder diarrheas or food disturbances; in the form of *Casec water* given in the immediate newborn period as a pre-lacteal food; as a well-tolerated fluid between feedings; and as a source of calcium in premature infants who suffer from amineralization (see page 208) of the skeleton and need much more calcium than human milk or any formula mixture can provide.

TABLE 25  
 III (E) PROTEIN SUPPLEMENTS  
 (Products supplying additional protein in complex (peptides and polypeptides) or simpler forms (amino acids))

Name of Product	Fat c%	Protein c%	CHO c%	Dry or Liquid	Calories per Oz.	Tabls. per Oz.	Added Vitamins or Minerals (per qt.)	Curd Tension (Grams)	Affected by Terminal Sterilization (Yes or No)	How Formulated or Reconstituted	Chemical Definition and Essential Clinical Uses
1. Casec <sup>®</sup> (Mead Johnson)	2 (not reconstituted)	88	0	D	105 (not reconstituted)	6	None	"not known"	No	As supplement—1 to 3 tbs. per bottle; or between feedings 1 tbs. per 2 oz. water	Concentrated protein (calcium caseinate) supplement designed for use in dietary treatment of diarrhea and "colic" of infants and children, and to supply ex- tra protein; essentially free of sodium, and an excellent source of calcium.
2. Lonalac <sup>®</sup> (Mead Johnson)	3.5	3.4	4.8	D	19	3½	None added	"not known"	No	3½ tbs. to 7 oz. wa- ter	Nutritionally similar to whole milk but virtually sodium-free; designed for use in low sodium diets.
3. Protenum <sup>®</sup> (Mead Johnson)	2 (not reconstituted)	42	46	D	105 (not reconstituted)	3½	none added	"not known"	No	3½ tbs. per 6 oz. water	Palatable high protein low fat food, valuable for rapidly grow- ing patients and others who have high protein requirements; does not delay gastric emptying time.

### III. (F) THERAPEUTIC ADJUNCTS AND DIETARY SUPPLEMENTS

There are other preparations available for infant feeding which are not to be classified strictly as foods but rather as therapeutic agents, and yet they stem from food origins which characterize many of the infant preparations. They are presented here since the indications for their use are concomitant to conditions for which specific infant foods are used, and they employ the principles which are fundamental to foods listed in these tables.

Three of the products are similar as to their therapeutic indication—acute, chronic and non-specific diarrheas. *Appella*<sup>®</sup> is a powdered apple juice derivative; *Arobon* is obtained from carob flour (“St. John’s bread”); and *Prohana*<sup>®</sup>, a uniform blend of protein milk, *Protolysate*<sup>®</sup>, banana powder and dextrose. All of these are used in the parenteral or specific diarrheas (details may be seen in Table 26).

Two new products have been made available and these reflect the public service which some companies contribute toward the infant feeding field. They are *Ketonil*<sup>®</sup> (*Merck*) and *Lofenlac*<sup>®</sup> (*Mead Johnson*). Either company will probably never realize a financial return on the research directed toward the supplying of these preparations to physicians for use in treating *phenylketonuria*, and yet these two products were made available.

*Phenylketonuria* is due to an inborn defect in the metabolism by the body of *phenylalanine*, one of the essential amino acids. It occurs in about 1% of mentally defective persons and is characterized by intellectual retardation, seizures, and other neurological signs and disorders. As a result of this metabolic difficulty *phenylalanine* accumulates in the blood, and abnormal metabolites appear in the blood and urine. It has been theorized that these abnormal metabolites or the excessive *phenylalanine* may have a toxic effect on the central nervous system producing the mental and neurological disorders. A typical acrid odor due to *phenylacetic* acid in the urine is a hint in the diagnosis and a ready test for the presence of *phenylpyruvic* acid by a simple ferric chloride test can be easily made.

TABLE 26

III (F) THERAPEUTIC ADJUNCTS AND DIETARY SUPPLEMENTS  
(Therapeutic agents stemming from food origins with specific functions in abnormal feeding situations.)

Name of Product	Fat c% (Reconstituted)	Protein c% (Reconstituted)	CHO c% (reducing sugars)	Dry or Liquid	Calories per Oz. (Recon- stituted)	Tabls. per Oz.	Added Vitamins or Minerals (per qt.)	Curd Tension (Grams)	Affected by Terminal Sterilization (Yes or No)	How Formulated or Reconstituted	Chemical Definition and Essential Clinical Uses
1. Appella <sup>a</sup> (Winthrop Labo- ratories)	—  (not reconstituted)	—  (not reconstituted)	52 (reducing sugars)	D	96 (not recon- stituted)	—	none added	—	Yes	4 teaps. to 8 oz. of any prescribed for- mula; or 4 teasp. to 8 oz. water between feed- ings	Pectin—5.2 c% Uronic acids—9.2 c% Reducing sugars—5.2 c% Kaolin—5.0 c% A highly concentrated and de- hydrated apple powder, for use alone in treatment of non-spe- cific diarrheas or as an adjunct to chemotherapy, or in normal infant feeding.
2. Arobon <sup>a</sup> (Pitman-Moore— formerly dist. by Nesle <sup>c</sup> )	0.5 (not reconstituted)	3.5 (not reconstituted)	49	D	71 (not recon- stituted)	—	none added	—	No	2-4 teaps. to 4 oz. formula, skimmed milk or water	Processed powder of carob bean (St. Joseph's bread) and contains legnin, pectin, tannic acid, hemicellulose and starch. Used in treatment of specific, non-specific and parenteral diar- rheas.
3. Ketoni <sup>a</sup> (Merck)	must be added to 35% of cal.	60.0	must be added to 50% of cal	D	75	4.5 (1 tblsp. equals 6.5 gm.)	Minerals similar to human milk added. No vita- mins added; must be supplemented	?	Sl. Browning	Scant tblsp. (5 gm.) ; Kg.: day equals 15 c% of cal.; add 50 c% cal. in a CHO and 35 c% cal. in a vegetable oil; with water to desired volume	Contains choline chloride, minerals and all essential amino acids except phenylalanine (0.1 c%). For use only in patients with phenylketonuria. (see text).
4. Lofenlac <sup>a</sup> (Mead Johnson)	2.7	2.2 (equivalent)	8.5	D	20	3½	2500—A 400—D	"not known"	No	3½ tbs. to 6 oz. wa- ter	Low phenylalanine food de- signed for use as sole or principal nourishment of phenylketonuric infants and children. (see text)
5. Lytren <sup>a</sup> (Mead Johnson)	— (not reconstituted)	—	92.03 (reconstituted)	D	100 (not recon- stituted)	4	(see analysis)	"not relevant"	not relevant	Dextri- Maltose <sup>a</sup> Na Citrate KCl NaH <sub>2</sub> SO <sub>4</sub> Ca lactate NaCl Citric Acid MgSO <sub>4</sub> Dextrose 10.0 c% 1.84 2.33 0.86 0.77 0.37 1.50 0.3 82.03	An oral electrolyte formula- tion with well-tolerated CHO; for replacement of fluid electro- lyte losses as in diarrhea, vomit- ing, surgery and febrile diseases.
6. Probona <sup>a</sup> (Mead Johnson)	2.0	3.9	7.3	D	20	3	none added	"not known"	No	1 tbs. to 2 oz. wa- ter	A high protein formula contain- ing banana powder and other in- gredients well tolerated in vari- ous digestive disturbances i.e., pancreatic fibrosis, celiac dis- ease, diarrhea.

Those interested in further details of this disease entity are referred to the bibliography (8, 83, 25, 68, 84, 190), or may write to *Mead Johnson & Co.* or *Merck Sharp and Dohne* both of whom have excellent brochures giving details of the disease and help in its care. Their products are essentially *phenylalanine deficient mixtures of amino acids and minerals* and must be supplemented by vitamins, fat and carbohydrate to complete the ration.

Analogous to *phenylketonuria* is another disturbance of amino acid metabolism which has recently been reported (107, 183). It is

TABLE 27  
AMOUNT OF PHENYLALANINE IN SOME COMMON FOODS (102)

Food	Phenylalanine (Gm./100 Gm.)
Whole egg . . . . .	0.8
Egg albumin . . . . .	0.9
Egg yolk . . . . .	0.7
Milk . . . . .	0.2
Liver . . . . .	1.2
Pork, fresh . . . . .	0.5
Steak, cooked . . . . .	0.8
Leg of lamb, fresh . . . . .	0.6
Leg of lamb, cooked . . . . .	0.8
Corn . . . . .	0.5
Whole wheat . . . . .	0.5
Oats . . . . .	0.7
White potatoes . . . . .	0.1
Peas and beans . . . . .	1.0

called *Maple Syrup Urine Disease* in which the smell of the urine is like that of maple syrup or burnt sugar. In this entity, like that of phenylketonuria, the blood plasma, cerebrospinal fluid and saliva contain derivatives of specific amino acids—*Maple Syrup Urine Disease* having high concentrations of the keto analogues of *leucine*, *valine* and *isoleucine* and which are responsible for the typical odor of the urine. The disease is characterized by early onset of spasticity and myoclonic seizures with rapid progression to decerebrate rigidity and mental degeneration. In both of these disease entities there is evidence of a disturbance of the tryptophan metabolism. A diet low in *leucine*, *valine* and *isoleucine* might be expected to benefit these patients in the same way that a diet poor in *phenylalanine* improves children with phenylketo-

nuria. At present there is no economically practical way of preparing such a diet for use over long periods of time.

### CONCLUSIONS ON BOTTLE-FED INFANT FOODS

It may be concluded that all of the 78 bottle-fed infant foods presented in this chapter in outline form, in tables, and in descriptive textual material represent a complete coverage of the needs of infants when deprived of human milk. It is observed that all of these preparations are confirmed by some scientific facts or principles elicited from nutrition research or the literature in this field. The difficulty from a practical viewpoint is that there is much duplication and herein lies the confusion experienced by the practitioner of infant feeding when faced by a decision from this plethora of products. It is hoped that the arbitrary classification suggested here will help clarify the dilemma which exists, and that the description of each food and the discussion of each group will better orient the reader and will help in making the many products more useful.

A suggestion is made by the author to the physician when faced with the burden of choice in this multiplicity of available milk foods. *Choose one or two of the products in each category* and become familiar with their chemical composition and clinical uses. When sufficiently acquainted with the two selected, the physician should then choose two others which could be used interchangeably. An acquaintance with the functions and composition of each *group* will also prepare for the *newer additions* in this field which will be sure to come. Thus any future important contributions to the field of infant nutrition will be made more lucid, when they appear in the literature or when they are illustrated in the commercial infant food market.

*We group things into classes by ignoring their differences, though the differences may be as important as the similarities.*

B. L. HERRINGTON, *ibid.*



FIG. 4. All Available U.S. and Canadian Carbohydrate Modifiers for Infant Feeding (twenty-seven) as of June 1, 1959.

## *Chapter Six*

### CARBOHYDRATE ADDITIVES AND MODIFIERS

WHEN OTHER mammals' milk (usually cow or goat) than that of human milk is used for infant feeding purposes the milk is diluted essentially to lessen the fat component, as well as to render the casein curd more flocculent. The carbohydrate is inadvertently diluted and hence is added back in the complete mixture to furnish additional calories for weight gain. There are many other reasons which make this an acceptable procedure in addition to caloric increase and to lessen the solute load on the immature infant kidney (32, 126, 23, 40).

#### PRINCIPLES EMPLOYED IN THE MANUFACTURE OF CARBOHYDRATE ADDITIVES

Here again the manufacturers sense this need and provide many acceptable products to supply it. As with the bottle-fed milk products, certain chemical and physiological principles obtain in the manufacture of these CHO modifiers. They are summarized here to orient the reader and to identify the principles which are necessary in the modification of milk mixtures:

- A. Addition of a larger proportion of dextrans to reduce fermentation.
- B. Increasing the per cent of maltose or lactose to produce more fermentation.
- C. Substitution of extraneous carbohydrates (fruit sugars) which seem to be more easily tolerated, such as banana and and pectin-fructose combinations; agents as Pectin-Agar-Dextri-Maltose<sup>®</sup>, which are said to coat the intestinal mucosa in gastroenteritis.
- D. Utilizing the observed fact that normal enzymatic action must occur, releasing absorbable monosaccharides more slowly in the infant bowel.

- E. Using non-cereal starches to avoid allergenic grain sources: removing allergenic proteins appearing with the starch molecule.
- F. Using starches of grains (barley, wheat, oats, corn, tapioca, rice) which because of their colloidal state, effect a more finely divided curd when combined with the casein in the stomach.

As with the various bottle-fed infant milk foods, the carbohydrates currently available in use for infant feeding are detailed in Table 30 which follows, and where their composition and uses are presented. No rigid classification of these products is attempted since none would be satisfactory except in a general description which is discussed in the text which follows the table.

### Suggested Classification as to Physical State and Origin

The carbohydrate additives and modifiers may be at once classified into *liquid* and *powdered* preparations. This obvious physical division is not of much consequence except in the facility of measuring them, in their ease of solubility and in the computation of calories and percentages.

A further division may be made on the bases of their origins and precursors, or, more simply stated, the complex carbohydrate (starch) from which they are obtained. The methods used for these processes are usually by *acid hydrolysis* or *diastase fermentation*, or some variation of these two procedures. The following is a list of the complex carbohydrates or starches from which the various carbohydrates are obtained: *potato*, *cornstarch* (and, from this product, *corn syrup*), *corn flour*, *tapioca*, the grains of *wheat* and *barley*, *banana*, *apple*, *whey of cow's milk*, *sugar beet* or *sugar cane* (and their by-product *molasses*), fruit sugar of many blossoms, which is *honey*.

### Theoretical Concept of Carbohydrate Digestion

For those who are confused by the multiplicity of the various components of starch found in the equally numerous commercial sugars available, this brief and generally accepted theory will help

clarify the confusion. It would seem logical to present to the infant gastrointestinal digestion the simplest monosaccharides for immediate absorption, and have done with the intervening steps of digestion from a higher to a lower order. This was not Nature's intent, however direct and efficient it may seem. (See Table 5.)

The plan appears to be that there is a natural economy in carbohydrate digestion—that each *amylolytic enzyme* must be used. The reduction of *starches* into *dextrins*, into *disaccharides* (maltose, and so on), into *monosaccharides* (dextrose, and so on) must go on, apparently to utilize all the digestive enzymes provided for this purpose. For this reason most of the carbohydrate additives consist of the varied higher components presented to the digestive apparatus for reduction. Therefore, in most commercial modifiers, polysaccharides and disaccharides are present at once in varied proportions as well as any of the split products of a lower carbohydrate order, and may be used for specific purposes. Those with larger amounts of dextrins naturally inhibit fermentation. When there is not enough fermentation, when the stool is soapy or firm, or when the stool is excessively putrefactive, one of the modifiers high in a fermentable sugar, such as *maltose*, is indicated.

### Generalization as to Sugar Additives

Varied claims have been made for each of the integral carbohydrate components of digestion, but in general it is safe to say that it matters little from whence the carbohydrate was obtained, how it was reduced from the raw product, or as to the content of the various reduction entities except as they are found to remain in ratio to each other. Anyone who becomes didactic on any of these points will be supported by many clinical proofs and laboratory data. Anyone else who wishes to refute the position as to the greater value of one carbohydrate component over another will also have available adequate proofs in the literature. It appears, then—for the *normal* infant digestive tract—that all the commercial carbohydrates now to be listed are adequate for their specified purposes, the guidon being the simple physiologic principles of digestion mentioned in Chapter II.

## PERTINENT FACTS ON SPECIFIC CARBOHYDRATE ADDITIVES

Certain of the carbohydrate modifiers may be mentioned which are of special practical interest to the reader without adverse inference implied to those not so mentioned. All of these are reliable, adequate, dependable and usable within the realm of infant carbohydrate digestive requirements. As with the bottle-fed infant foods, there is much duplication in this category and many of the products could be used interchangeably with no disadvantage or digestive insult to the infant.

*The Corn Syrups.* The corn syrup products are tolerated by most infants and were the ones (*Karo Syrup*<sup>®</sup>) used by Brenne-  
mann and Marriott in their original investigations on curd tension studies with evaporated milk. The corn syrup preparations are the

TABLE 28  
AVAILABLE CARBOHYDRATE MODIFIERS AND ADDITIVES

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1. Beta Lactose <sup>®</sup> (D)—(Borden)
2. Brown Sugar—(D)—(any brand or manufacturer found in grocery trade)
3. Cane or Beet (granulated) Sugar (D) (any brand or manufacturer found in grocery trade)
4. Cartose <sup>®</sup> (L)—(Winthrop Lab.)
5. Chiquita's Mashed Banana (L)—(American Home Foods)
6. Dexin <sup>®</sup> (D)—(Burroughs Wellcome)
7. Dextri-Maltose <sup>®</sup> #1 (D)—(Mead Johnson)
8. Dextri-Maltose <sup>®</sup> #2 (D)—(Mead Johnson)
9. Dextri-Maltose <sup>®</sup> #3 (D)—(Mead Johnson)
10. Pectin-Agar in Dextri-Maltose <sup>®</sup> (D)—(Mead Johnson)
11. Dextrosol (D)—(Canada Starch Co.)
12. Hidex <sup>®</sup> (D)—(Winthrop Lab.)
13. Honey (Lake Shore Clover) (L)—(W. F. Straub & Co.)
14. Instant Lactose (D)—(Foremost Dairies)
15. Kanana <sup>®</sup> Banana Flakes (D)—(Kannengiesser & Co.)
16. Karo Syrup <sup>®</sup> —Red Label (Light) (L)—(Corn Products Refining Co.)
17. Karo Syrup—Blue Label (Dark) (L)—(Corn Products Refining Co.)
18. Lilly White Corn Syrup (Light) (L)—(Canada Starch Co.)
19. Crown Brand Corn Syrup (Dark) (L)—(Canada Starch Co.)
20. Karo Corn Syrup (L)—(Canada Starch Co.)
21. Lactose (D)—(Merek Sharp & Dohme)
22. Malt Soup Extract (L)—(Borcherdt Co.)
23. Malt Soup Extract Powder (D)—(Borcherdt Co.)
24. Molasses—Brer Rabbit Brand (Dark) (L)—(Pennick & Ford)
25. Molasses—Gold Label Brand (Light) (L)—(Pennick & Ford)
26. Sweetose <sup>®</sup> Crystal Syrup (L) (A. S. Staley Mfg. Co.)

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(Carbohydrate Modifiers discontinued 1952-1959: *Alerdex*<sup>®</sup> (Wyeth); *Dextri-Maltose*<sup>®</sup> with Yeast Extract and Iron (Mead Johnson); *Malose* (Borcherdt); *Mellins Food*<sup>®</sup> (Mellin Food Co.); *Infose*<sup>®</sup> (Borden); *Melori-pe Banana Powder* (Food Concentrates).

least expensive, are easily soluble and all enjoy great favor with physicians in infant feeding. Others are *Sweetose*<sup>®</sup>, *Cartose*<sup>®</sup>, *Lilly White*, *Crown Brand* and *Karo Brand Corn Syrup* (the last three being products of the Canada Starch Co., a subsidiary of Corn Products Refining Co. of New York). The Canadian product (Karo) is slightly different in flavor from the American Karo but similar to Crown Brand Syrup, and from a practical viewpoint like their United States counterparts. It is the experience of the author that in some infants, the corn syrups are more easily fermented and cause looser stools, although this cannot be borne out by an examination of their component parts—it is merely a private clinical impression. For this reason, they might also be used other than

TABLE 29

## CLASSIFICATION OF CARBOHYDRATE MODIFIERS AS TO MANUFACTURERS

**AMERICAN HOME FOODS**

Division of United Fruit Co.

22 E. 40th St.

New York 16, N. Y.

Chiquita's Mashed Banana

**BORCHERDT COMPANY**

217 N. Wolcott Ave.,

Chicago 12, Ill.

Malt Soup Extract

Malt Soup Extract Powder

**THE BORDEN COMPANY**

Pharmaceutical Division

350 Madison Ave., New York 17, N. Y.

Beta Lactose<sup>®</sup>**BURROUGHS WELLCOME & CO., INC.**

1 Scarsdale Road,

Tuckahoe, New York

Dexin<sup>®</sup>**CANADA STARCH CO. LIMITED**

P.O. Box 128

Montreal, Quebec, Canada

Dextrosol

Lilly White Brand Corn Syrup

Crown Brand Corn Syrup

Karo Corn Syrup

**CORN PRODUCTS REFINING CO.,**

17 Battery Place,

New York 4, N. Y.

Karo Syrup<sup>®</sup>—Red LabelKaro Syrup<sup>®</sup>—Blue Label**FOREMOST DAIRIES, INC.**

425 Battery St.

San Francisco 11, Calif.

Instant Lactose

**KANNENGIESSER & CO., INC.**

76 Ninth Ave.,

New York 11, N. Y.

Kanana<sup>®</sup> Banana Flakes**MEAD JOHNSON & CO.**

2404 Pennsylvania Ave.,

Evansville 21, Ind.

Dextri-Maltose<sup>®</sup> #1Dextri-Maltose<sup>®</sup> #2Dextri-Maltose<sup>®</sup> #3Pectin-Agar in Dextri-Maltose<sup>®</sup>**MERCK SHARP & DOHME**

Division of Merck &amp; Co.

Rahway, New Jersey

Lactose

**PENNICK & FORD, LTD. INC.**

750 Third Ave.,

New York 17, N. Y.

Molasses Brer Rabbit Brand

Molasses Gold Label Brand

**A. S. STALEY MANUFACTURING CO.**

Decatur, Ill.

Sweetose<sup>®</sup> Crystal Syrup**W. F. STRAUB & CO.,**

5514 Northwest Highway,

Chicago 30, Ill.

Lake Shore Clover Honey

**WINTHROP LABORATORIES**

1450 Broadway,

New York 18, N. Y.

Hidex<sup>®</sup>Cartose<sup>®</sup>**NON-SPECIFIC PRODUCT MANUFACTURERS**

Brown Sugar

Cane or Beet Granulated Sugar

routinely, as when the stools appear to be hard and difficult to pass when no important physiological cause exists.

*The Dextri-Maltose<sup>®</sup> Products.* The *Dextri-Maltose<sup>®</sup>* preparations, introduced in 1911, have long enjoyed the confidence of physicians in general. It may be observed here, without prejudice or biased partiality, that these products have exercised this unusual popularity with successive generations of physicians because of their dependability, and the belief in the integrity of the clinical and laboratory research which has sustained them in the field of infant feeding. It is not credible that this favor has been acquired by the policy of ethical advertising or efficient promotion methods alone. These preparations must have had merit to sustain their rank by their selection by physicians for almost 50 years. A failure to qualify as satisfactory carbohydrate modifiers would have been tantamount to eclipse—a critique stronger by far than mere tradition and the habit of conventional prescribing of the familiar.

A small point of instruction is made here regarding a fallacy prevalent among many laymen and some physicians that three of the *Dextri-Maltose<sup>®</sup>* preparations are labeled #1, #2, and #3 so that they may be used successively as the infant grows older. This of course is erroneous. *Dextri-Maltose<sup>®</sup>* #1 is the one most often used for routine infant feeding. *Number 2 Dextri-Maltose<sup>®</sup>* differs from #1 only in that there is added 50 mg. of ascorbic acid per oz., which was changed about 8 years ago from being sodium free. *Dextri-Maltose<sup>®</sup>* #3 is like #1 except for the addition of 3% potassium bicarbonate which is said to counteract a tendency to the formation of hard calcium soaps in the stools—the proportion of potassium being higher than the calcium as in human milk, and hence is more laxative. Both preparations, #2 and #3, enjoy certain geographically-sectional or provincial popularity among some physicians, and no matter the slight chemical differences in these products, a keen sense of commercial propriety apparently warrants their continued availability by the manufacturer.

*Facts About Other Modifiers.* The need of a dependable banana-derived CHO (*Kanana<sup>®</sup> Banana Flakes* and *Chiquita's*

TABLE 30  
CARBOHYDRATE MODIFIERS AND ADDITIVES

Name of Product	Dry or Liquid	Calories per Oz. (not reconstituted)	Tabls. per Oz.	Affected by Terminal Sterilization (Yes or No)	Chemical Content (not reconstituted)	Description and Essential Clinical Uses
1. Beta Lactose <sup>2</sup> (Borden)	D	114	3	No	Beta lactose 98.5% Alpha lactose 1.0 Ash 0.015	An anhydrous lactose 5 times more soluble, and more palatable than USP milk sugar. Promotes fermentation in putrefactive flora; is more laxative. Used also as a supplement to human milk, and in early newborn period before food is begun.
2. Brown Sugar (Any commercial brand)	D	125	2	No	Iron 2.6 mg. per 100 gm. Sodium 24 mg. per 100 gm. Potassium 230 mg. per 100 gm. Calcium 76 mg. per 100 gm. Phosphorus 37 mg. per 100 gm.	The end product of a sugar solution when it is evaporated to crystallization in an open vessel. The crystals which separate on cooling are freed from the mother liquor (molasses) by centrifugal machines. This syrup-containing product (brown sugar) is still further refined to produce granulated sugar, all of which products are obtained from sugar cane or beets. It is used provincially as a CHO additive in milk mixtures for infants and is more laxative.
3. Cane or Beet Sugar (Any commercial brand)	D	120	2	No	Refined commercial product, sucrose or granulated sugar, used most commonly in the home. Breaks down from its disaccharide to the monosaccharides—dextrose and levulose	Not easily fermented in the intestinal tract, inexpensive, sweeter, easily available, stable and well tolerated by infants as a CHO additive in milk-base mixtures.
4. Cartose <sup>2</sup> (Winthrop Lab.)	L	120		No	Dextrins 41% Dextrose 17% Maltose 16% Ash 0.2%	Mixed CHO liquid containing dextrins, maltose and dextrose derived from pure corn starch by live steam hydrolysis. Less likely to produce digestive disturbances than single sugars. The higher sugars are gradually digested assuring space absorption of digestive products reducing CHO fermentation in excess.
5. Chiquita's Mashed Banana (American Home Foods United Fruit Co.)	L	25	2	No	Carefully ripened fruit pulp (no additives or preservatives added). Chemical content identical to that of fresh banana except for a slight loss in ascorbic acid and thiamine as a result of processing	A convenient form of banana for use in normal infant feeding; also for use in celiac disease, infant and adult diarrhea, and certain forms of dysentery.

TABLE 30—Continued

Name of Product	Dry or Liquid	Calories per Oz. (not reconstituted)	Tabls. per Oz.	Affected by Terminal Sterilization (Yes or No)	Chemical Content (not reconstituted)	Description and Essential Clinical Uses
6. <b>Dextrin</b> <sup>®</sup> (Burroughs Wellcome & Co., Inc.)	D	115	6	No	Maltose 24% Dextrin 75% Ash 0.25% Water 0.75%	Milk modifier for infant feeding formulas. High dextrin content ensures low fermentability. Also a dietary adjunct for older children and adults.
7. <b>Dextrin-Maltose</b> <sup>®</sup> #1 (Mead Johnson)	D	110	4	No	Maltose 56% Dextrins 42%	A highly palatable not too sweet CHO formula modifier for use with evaporated or bottled milk or special powdered milks in feeding all infants capable of ingestion.
8. <b>Dextrin-Maltose</b> <sup>®</sup> #2 (Mead Johnson)	D	110	4	No	Same as Dextrin-Maltose <sup>®</sup> #1 with 50 mg. of added ascorbic acid per oz.	Same as Dextrin-Maltose <sup>®</sup> #1 particularly for premature infants.
9. <b>Dextrin-Maltose</b> <sup>®</sup> #3 (Mead Johnson)	D	110	4	No	Same as Dextrin-Maltose <sup>®</sup> #1 with 3% KHCO <sub>3</sub> added.	Same as Dextrin-Maltose <sup>®</sup> #1 but designed especially to aid in counteracting constipation.
10. <b>Pectin-Agar in Dextrin-Maltose</b> <sup>®</sup> (Mead Johnson)	D	100	4	No	Dextrin-Maltose <sup>®</sup> 87.6% Pectin (100 grade) 6.3% Agar 4.3% NaCl 1.8%	Used in milk, in formulas, or by spoon feeding, in certain disturbances of intestinal function i.e. diarrhea. Helps normal stool formation and provides CHO.
11. <b>Dextrosol</b> (Canada Starch Co.)	D	100	4	No	Pure Dextrose (d-Glucose Powder), a white crystalline sugar, mild-sweet highly stable	May be used orally with fluids; fruit juices, milk formulas; rectally as 5% isotonic solution; subcutaneously as 5% solution; intramuscularly as a 5-10% solution.
12. <b>Hidex</b> <sup>®</sup> (Winthrop Lab.)	D	112	4	No	Dextrin 83% Maltose 7.5% Dextrose 7.5% Iron 5 mg. per oz.	Slowly digestible, non-irritating and relatively non-fermentable. Used as a modifier of infant milk formulas, especially useful in dietary management of digestive disturbances in infants.
13. <b>Honey, Strained Liquid</b> ("Lake Shore Clover Honey," W. F. Straub & Co.)	L	132	Approx. 2	No	Levulose 40.5% Dextrose 34.2% Water 17.2% Small amts. of dextrins, iron, copper, vit. B <sub>1</sub> complex and vit. K	Carefully selected, pasteurized "Lake Shore Clover Honey" is filtered free from pollens and has a definite place in infant feeding.
14. <b>Instant Lactose</b> (Foremost Dairies)	D	113	5½ (metered cartons dispensing ½ oz. on each pouring)	No	Milk sugar—Lactose	"Instantized" so it is free-flowing, instantly soluble. Use as the natural CHO modifier for infant feeding formulas to give the formula the same lactose content as human milk.

TABLE 30—Continued

Name of Product	Dry or Liquid	Calories per Oz. (not reconstituted)	Tabls. per Oz.	Affected by Terminal Sterilization (Yes or No)	Chemical Content (not reconstituted)	Description and Essential Clinical Uses
15. Kanana <sup>®</sup> Banana Flakes (Kannengrasser Co.)	D	109	4	Yes (sl. coagulation of banana starch but no effect on chemical quality)	Fat 1.3% Protein 6.37% Ash 2.83% Moisture 5.52% Total CHO 83.48% (made up of reducing CHO, dextrose and starch)	Pure sun-ripened, dehydrated banana. Three parts liquid to one part flakes produces non-allergenic banana. Used as a milk modifier, as baby's first solid food, infantile diarrheas, Celiac Syndrome, gastrointestinal disturbances.
16. Karo <sup>®</sup> Syrup <sup>*</sup> Light-Red Label (Corn Products Refining Co.)	L	120	2	No	Dextrin 36.0% Maltose 18.0% Dextrose 12.0% Sucrose 9.0% Ash 0.2% Vanilla flavor +	A mixture of sugars containing a large proportion of mixed dextrins; smaller amts. of maltose and dextrose; refined corn syrup and salt. Used in infant feeding as a CHO modifier.
17. Karo <sup>®</sup> Syrup <sup>*</sup> Dark, Blue Label (Corn Products Refining Co.)	L	120	2	No	Dextrin 37.0% Maltose 18.0% Dextrose 12.0% Sucrose 4.0% Invert sugar 3.0% Ash 0.6% Refiner's Syrup +	Same as above. The chemical or physiological difference between the light and dark Karo Syrup is negligible, and may be used interchangeably in infant formulas because of equivalent nutritive and digestive action.
18. Lilly White Corn Syrup (Canada Starch Co.)	L (light)	90	—	No	Corn syrup together with a small quantity of sucrose and vanilla	Sucrose 8.25% Dextrose 13.0% Maltose 9.75% Invert sugar 0.5% Higher sugars 44.5% Chloride ash 0.26% Moisture 23.5%
19. Crown Brand Corn Syrup (Canada Starch Co.)	L (dark)	90	—	No	Corn syrup together with a small quantity of sucrose, refiner's syrup (molasses) and salt	Sucrose 6.00% Dextrose 13.0% Maltose 9.75% Invert sugars 2.25% Higher sugars 44.5% Chloride ash 0.46% Moisture 23.5%
20. Karo Corn Syrup (Canada Starch Co.)	L	120	2	No	Sucrose 5.25% Dextrose 12.75% Invert sugar 4.0% Maltose 9.5% Higher sugars 44.25% Chloride ash 0.49% Moisture 23.5%	Ideal milk modifier for all types of infant feeding formulae. Completely absorbed and utilized, as each sugar is assimilated at its intestinal level.

\* The manufacturer of these items was the only one who did not return the form regarding their products despite the receipt of the registered mail blank. The data appearing here is taken from their current literature and from the former text in which they did respond.

TABLE 30—Continued

Name of Product	Dry or Liquid	Calories per Oz. (not reconstituted)	Tabls. per Oz.	Affected by Terminal Sterilization (Yes or No)	Chemical Content (not reconstituted)	Description and Essential Clinical Uses
21. Lactose (Merck Sharp and Dohme)	D	120	3 to 3½	Slight browning	Pure Milk Sugar—Lactose. (C <sub>12</sub> H <sub>22</sub> O <sub>11</sub> ) Sold under name of Milk Sugar though label also bears name Lactose USP	The sugar found naturally in milk. For use as CHO in infant formulas.
22. Malt Soup Extract (The Borchardt Co.)	L	120	2	No	Non-diatomite barley malt extract neutralized with potassium carbonate	A laxative modifier of milk for constipation in infants and children. Use ¼ to 2 tbs. in the day's feeding, or 1 to 2 tsp. in a single feeding.
23. Malt Soup Extract Powder (The Borchardt Co.)	D	105	4	No	Same as above	The dry equivalent of the above. One to 4 tbs. in the day's feeding or 2 to 4 tsp. in a single feeding.
24. Molasses, Brer Rabbit Brand (Pennick & Ford)	L (dark)	119	1½	No	Sucrose 42.5% Dextrose 9.0% Levulose 9.0% Higher sugars 12.0% Ash 6.0% Calcium 0.27% Total iron 0.0105% Available iron 0.0095%	Residual product obtained from sugar cane juice. Use principally as food and as a base material for the fermentation industry. Molasses is used principally as a (CHO) modifier in milk mixtures for infants, especially in the southern U. S. where economy and availability are factors. The available iron (80-90%) exceeds all other foods, even eggs and liver, and hence is the most inexpensive and natural source of iron. (See text on laxative and fermentative qualities.)
25. Molasses, Gold Label Brand (Pennick & Ford)	L (light)	119	1½	No	Same as above	The lighter colored molasses differs only from the dark in that it appears more attractive and represents a higher extracted stage in the refining process of cane sugar.
26. Sweetose® Crystal Syrup (A. S. Staley Mfg. Co.)	L	120	2	No	Moisture 25.2% Dextrose 25.6% Maltose 23.4% Higher sugars 11.0% Dextrins 8.3% Sucrose 6.3% Ash 0.2% Available CHO 74.6%	A blend of corn syrup and granulated sugar syrup containing no added flavoring. Used for a (CHO) additive in milk mixtures for infants. Much sweeter and more fluid than the usual acid-converted corn syrup.

*Mashed Banana*) is filled by these two products, with the attention being accorded to the fat intolerance states of the celiac syndrome, including cystic fibrosis of the pancreas. They are also practical, as in some of the non-specific diarrheas and common clinical intolerances seen in any infant feeding practice where they may be used safely to satisfy an infant's high caloric needs in the face of such temporary intolerances (188, 58).

It has been recently observed that since more bananas are being used in diets more data is accumulating that allergenic properties exist, presumably in the protein fraction (1.2 per cent) of raw, ripe bananas. Fries and Glazer (59) demonstrated by animal sensitizing tests, and with two children markedly allergic to raw banana, that this sensitivity is not present in the dehydrated banana preparation. It would seem to indicate that in the process of dehydration by heat, the antigen is so altered that its allergenic properties are destroyed. It is therefore assumed that there is a definite place for the dehydrated banana preparation in the hypo-allergenic diet.

*Molasses*, processed and extracted from crushed sugar cane, has never been suggested as a CHO modifier in milk mixtures for infants by any manufacturer of the product, but it has been used and recommended sporadically in various sections of the country for this purpose. A manufacturer of molasses (*Brer Rabbit* brand—Pennick and Ford) has promoted the fact that molasses as a food is rich in available iron, and has supported research to this effect. Harris, *et al.* (71), at the Massachusetts Institute of Technology have critically examined this claim, and have found by a chemical process (modified dipyridyl method) that molasses is superior to all foods in available iron, ranking above that of liver, kidney, raisins, and even egg. This compares with the values given by Sherman, *et al.* (158, 184). One tablespoon of molasses ( $\frac{3}{4}$  oz.) contains 1.64 mg. of iron (0.0073%), which is more than one egg—1.35 mg. Molasses is also rich in calcium (0.27%), or 60.75 mg. per tablespoon.

There is little clinical mention of the use of molasses in texts, in the literature or by query of many physicians in different parts of the country. However, W. C. Davison, in earlier editions of *The Compleat Pediatrician* (45) recommends its use in examples

of his stock formulas for infants as a satisfactory carbohydrate modifier because of its economy, and especially for the high available iron and calcium content. In a personal communication with the author recently, Dr. Davison points out that in the last edition of his book, he emphasizes the distention, loose stools, and vomiting that may occur when molasses is used as a modifier, especially in premature and weak infants. Dr. J. A. Bigler, in a personal statement on inquiry, states that he has long used molasses as the CHO, or in addition to the modifier, for infant milk mixtures when a fermentative or laxative agent was indicated. More clinical data in the use of this CHO are needed, both in normal infants and in those with nutritional anemias in the first year of life.

The more fermentative disaccharides are represented well by the modifiers high in maltose (Borcherdt's *Malt Soup Extract*, Liquid and Dry). Most physicians have known of these products for many years, and they are most useful clinically for the infant with hard stools which are easily made satisfactory by modifying any formula mixture with either of these two products.

It is a strange anomaly in infant feeding that the "natural" carbohydrate *Lactose* has not been a favorite modifier for milk mixtures when it is found (7.5%) in human milk and from 2.0 to 8.5% in the milks of every species of mammals. As the natural CHO found in the food of every young mammal it might be expected to hold a special place in pediatric practice and yet it has been given little attention, and the opinions about its value differ widely. In a comprehensive review of the literature of the subject by Dunean (51) the history of lactose is given a complete exposition, and several truths are evident from this excellent discussion. In 1930 the value of lactose was recognized for use in infant feeding but for 40 years before, it had been regarded as a dangerous substance and to be avoided. The probable reason for this lay in the teaching of Finkelstein (1906) and his school, who believed that lactose or acids caused by its fermentation produced inflammation of the alimentary tract and that the inflamed mucosa allowed undigested food components, including lactose itself, to be absorbed. So effective was his teaching that subsequent writers and investigators accepted his dicta without further questioning. In 1932 Sauer (149) wrote "It seems paradoxical that no one has tried to

enrich evaporated milk dilutions with lactose, the natural sugar occurring in breast milk." Sauer used lactose to modify diluted evaporated milk mixtures for 150 infants, some of them premature, and found that it gave results comparable with those given by human milk. Later investigators found that extra fermentation occurred only when the lactose content of the formula was increased too suddenly or when excessive quantities were given. Several writers express the opinion that it was indeed a mystery why lactose was unpopular with pediatricians.

In the commercial CHO available as modifiers for milk-base mixtures there have been 2 lactose preparations listed for years. *Beta-Lactose*<sup>®</sup> (Borden) has often been used as a pre-lacteal feeding, as a complement to breast feeding, and as a CHO additive. By its acid-producing media it invites fermentation instead of a putrefactive flora in the intestine. *Lactose* U.S.P. (Merck) has not been promoted especially for infant feeding purposes, its main use being in the pharmacy as a sweetening agent and as a vehicle for other medical ingredients in prescription preparations. The cost of the forms of lactose on the market and the difficulty of its solubility have not encouraged its use in milk mixtures other than in one-formula milks. A new product *Instant Lactose* (Foremost Dairies) has recently been made available, is readily soluble, free-flowing in a metered carton, and is said to be less expensive than the vegetable carbohydrate additives used for infant feeding. Physicians interested in local supplies should contact the manufacturer (Foremost Dairies) until national distribution has been established.

*Honey* has a long history of an accessory to infant feeding dating back to Old Testament days, and it has been used in the Middle and Far East for this purpose probably because of its availability. Observing its composition it may be seen that it can be classified with the group of modifiers low in dextrins but high in disaccharides. The *levulose* (39%) is slowly released while the *sucrose* (34%) is promptly taken up. *Honey* is unusual in that it contains appreciable amounts of iron, copper and manganese, and a Japanese investigator found that the minerals in honey were readily available for hematopoietic stimulation in experimental animals. Several series of infant feeding experiments have been

conducted in which the infants fed honey as a CHO additive to the milk mixture progressed as well or better than the controls with other CHO modifiers judged by "weight gain," "ease of digestion," and "ability to control diarrhea" (176, 150). Its relative economy would also be an asset where this factor is to be considered.

It is meted that a note should be made as to the passing of a venerable and steadfast modifier known as *Mellin's Food*<sup>®</sup> (Mellin Food Co. of Boston, Mass.). This additive has been manufactured since 1886 and has just recently been discontinued. *Mellin's Food*<sup>®</sup> consisted of a dried extract from an infusion of wheat and barley starch. It was used widely in early years with success in difficult feeding situations and its value was probably due to the empiric employment of the colloidal curd softening effect of adding cereal waters to milk mixtures, a fact known and used before Marriott and Brennemann demonstrated this important need in the infant digestion. As mentioned before—evaporation, boiling, dilution, homogenization, acid or alkali addition or enzyme action, together with cereal water addition will all aid in producing a more flocculent curd.

### Milk Mixtures Without Added Carbohydrate

There is an expanding interest and literature on the subject of infant milk mixtures *without added* carbohydrate. This variation is not new. It is recognized as one of the earlier eras in the history of infant feeding, and was widely practiced in England and France during the last century. It is apparently part of a cycle to which infant feeding is returning, a "vogue" as one finds in many other phases of medicine. There are numerous reports recently of many thousands of infants who have been fed by this method with satisfactory nutritional results, as noted by the reports in the literature on this subject, notably in the paper by Harris (72).

No valid reason is apparent why this method of infant formula construction has not been more widely accepted and used, if it is as adequate and simple as the investigators have found. It may be at present an innovation, with no concerted effort to disprove it. It is also a deviation from an established convention, which is normally resisted when precedence has been established.

The scientific evidence in favor of adding carbohydrates to diluted cow's milk, or in fortifying premodified milks, is weighted with better reasons than empiric custom and tradition. Uncomplicated calculation and simplicity in formula construction may be the modern watchwords, but nutritional data point to values more important than these. The following accepted roles for adding sugars to milk mixtures for the feeding of infants have long been credible and accepted by nutritionists: it permits *normal metabolism of fat*, allows *protein to be used to build new tissue* rather than to provide calories (protein-sparing effect), encourages *normal water balance* which acts as an added safety factor against dehydration, *reduces the water excretory capacity* of the immature kidney of the infant, *influences electrolyte balance* and points up a relationship among carbohydrates, sodium and potassium not yet clearly defined (32, 126, 23, 40).

A clinical value has been observed by many practitioners of infant feeding which is of importance. Babies who receive no carbohydrate in the milk mixture appear to be hungry and dissatisfied with their food. When the same formula is fortified with sugar, they are happier and much more content. Other clinical advantages are that greater weight gains are noted which may be interpreted as being beneficial if used in reasonable proportions, the sugars are inexpensive and easily available, they are readily digested and are high in energy sources. A still more practical advantage is the use of the carbohydrate in the formula to affect the character of the stool, whether loose or too formed.

The excuse for devoting an unusual amount of space to this subject is based upon the fact that it is apparently a "fashionable" trend in infant feeding at present. Therefore it might be well if the reader becomes informed on a new deviation of an inevitable cycle which this phase portends. It may be that much of the success in any change from conventional procedure in infant feeding in the present day may be credited to the custom of beginning solid food supplements so early in the first year as is now practiced. The fortified, precooked cereals are offered as early as the sixth week, and soon are followed by vegetables, egg yolk and fruits. Any deficit that might otherwise be noted in the milk mixture is adequately supplemented by these accessory

foods, and thus success can attend almost any deviation or deficiency in the milk formula.

### CONCLUSIONS ON CARBOHYDRATE ADDITIVES

As was said with the use of the Bottle-Fed Infant Foods, the multiplicity of products in this category should not be confusing but rather helpful in the physicians' versatility in using the armamentarium of products available for use in infant feeding. A clinical suggestion is made: to become acquainted with several of the products and adapt them to use until familiarity with them has been achieved. After this, several more could be employed and the physician will soon find the wide range of usefulness of all of these products within the expected limits of their specified functions; or he may become satisfied with a combination which suits his particular demands of the carbohydrate modifiers available. He will surely be prepared for any new product which may enter the field by understanding the uses and principles of the products presently manufactured.

*When it is not in our power to determine what is true,  
we ought to act according to what is most probable.*

RENE DESCARTES

## Chapter Seven

### MECHANICAL BOTTLE-FEEDING PROBLEMS

THE PROBLEM of having available chemically and physiologically-acceptable milk food for most infants has long been solved. If any difficulty exists it may be said to be the burden of choice of which of the many acceptable foods are to be selected. Despite the equanimity which prevails in this realm of safe and adaptable foods, some enigmas of bottle feeding still are presented to the physician who sees the infant in the home or in his office practice. The crux of these difficulties lies in the area of delivering this nutritionally-acceptable-food into the infant by means of the various mechanical devices invented for this purpose.

#### Essential Components of Main Difficulty

Part of the natural endowment of the newborn infant is a deep-seated sucking reflex which does not include an adaptability for taking liquid food from a rigid vessel from which an equal amount of air must be evacuated for each quantity of fluid received. No such problem is evidenced in the collapsible and malleable maternal breast for which the innate sucking skill was designed. The most apt example of the difference, respectively, between intransitive and transitive verbs is in the copy-book truism—"A baby *nurses* the mother's breast but he *is fed* milk in a bottle." It is because of this difference of milk "containers" offered the baby that most of the difficulties arise.

Mute evidence that this mechanical problem is a pertinent one is noted by the fact that at least 9 popular types of bottle nipples, several removable valves, and an especially-designed collapsible bottle have been devised to help remedy this apparently frequent difficulty. Before modern industry embarks on the manufacture of an item there is usually a serious survey conducted to prove a need. If no need existed for solving this ubiquitous problem there

would be little demand for the ingenuity of these inventions nor for their manufacture and general use.

Most experienced clinicians will admit that about 75 per cent of the regurgitation, post-prandial distress, over- and under-feeding and error's of judgment on the part of the physician as to the infant's symptoms—all lie in the mechanical rather than in the organic realm of the newborn baby's problems.

After about the age of three months, the problem is often solved by the infant's skill learned by trial and error, but many basic psychological problems (such as rumination, habitual regurgitation, willful vomiting) have their nuclei formed in this period, which present themselves in distorted forms throughout the subsequent childhood. Many efforts on the part of the physician who vainly switchees from one formula to another in the hope of curing the infant's "colic," could be eliminated if more recognition were given to the mechanical problems in the act of food taking of the bottle-fed baby.

**Sequence of Events.** The new infant begins the sucking motion when his lips are stimulated by contact. When the rubber nipple is placed in the mouth, it is grasped by the lips, the tongue literally is wrapped around the nipple, and a mechanical, rhythmic, aspirating movement ensues. Each sucking motion is followed by that of swallowing, and the process continues automatically with breathing alternating with swallowing, or the breathing is held in abeyance until every fourth or more sucking effort. It makes no immediate difference to the baby whether he is swallowing liquid or air—the strong instinctive act of deglutition follows each equally strong sucking effort.

When any fluid is removed from a closed and rigid vessel of any size or shape where the only opening or exit is smaller than the greatest diameter, an equal volume of air must displace the liquid which is poured or aspirated from the vessel, or else a vacuum is formed preventing further removal of liquid. Precisely when a baby suks from a rigid or glass bottle, he must release the hold on the nipple after several efforts to relieve the negative pressure he has set up, or he continues to suck but obtains nothing but air (see also page 152 for mechanical effect). Two events of practical importance occur when this transpires:

1. The infant continues to suck indefinitely against a vacuum and a collapsed nipple until fatigue overtakes him, and having exhausted all of his sucking effort for that feeding, falls asleep and refuses to suck more. Not having ingested any hunger-satiating quantity of milk, he soon recovers from his fatigue and is hungry again. If the infant is fed again at this time and the entire sequence is repeated, true *over-feeding* may ensue. Since many different separate fractions of the feeding are admitted to the stomach at intervals, each successive digestive effort on the part of the stomach is inhibited by the addition of new amounts of food. The stomach is filled with food, digestion and emptying time are delayed, and distress and regurgitation may follow.

2. The more dramatic event, however, is that the sucking effort is followed by air swallowing (aerophagia), and soon the baby succumbs to the feeling of satiety because his stomach is filled with air (Figure 5), which physiologically is as effective as food in allaying the violent hunger contractions. This bolus of air either slowly escapes, leaving him with no food to sustain him or more spectacularly the air, as it does in any closed vessel, rises to the top and inadvertently pushes along any food which may have been taken, resulting in a projectile emesis or regurgitation. This latter event leads to more distress on the part of the infant than any other difficulty in the entire sequence of infant feeding. It was Dr. Brennemann's oft repeated impression that, excluding pylorospasm and pyloric stenosis, air swallowing accounted for ninety per cent of the regurgitation of food which occurs within the first thirty minutes after a feeding in the first three months of life. This inevitably is the cause of much distress on the part of the parents, much hunger on the part of the infant, failure of weight gain, and infrequent or scanty stools. It also causes the physician to lose faith in his own opinion as to the evaluation of the food prescribed, and tempts him to wrong conclusions as to its reception and digestion by the infant.

### **SUCKING VERSUS SUCTION**

When the act of *sucking* is engaged in by the infant the presumption by many is that *suction* is implied. Those who have been curious about the process have never assumed this inference. Recently, by the use of cineradiographic films (moving film of infants in-



Fig. 5. Roentgenogram of a clinical case of projectile vomiting due to air swallowing. Stomach completely distended with bolus of swallowed air. (C.S., infant four days old admitted to hospital from the newborn nursery of another institution because of constant projectile vomiting with resultant dehydration and marked weight loss. No pylorospasm or pyloric stenosis was demonstrated. With large-holed nipple, feeding in erect position, careful technic in eructating air after every ounce of milk mixture—infant was discharged on fifth hospital day with no vomiting and on full formula. Roentgenogram supplied by courtesy of Dr. Harvey White, Attending Radiologist, Children's Memorial Hospital, Chicago.)

gesting barium suspension and milk) at 25 frames per second, Ardran *et al.* (7) have demonstrated that the following mechanism occurs:

1. The lower jaw is moved upward and forward.
2. The neck of the nipple is compressed between the upper and lower gum with the tip of the tongue at rest on the lower gum.
3. The tongue moves from before backward thus forcing milk into the mouth by the front of the tongue compressing the nipple against the hard palate.
4. After the nipple is emptied the lowering of the jaw and the tongue causes some suction which probably aids in refilling the nipple but only a trace of milk enters the mouth as a result of this suction effect.

Thus suction has been shown to have a minor role in the sucking act. The authors state that if suction were the most important means of obtaining liquid from a bottle, it would be desirable that the tip of the nipple would not penetrate the mouth beyond the tip of the tongue, as in sucking through a straw. They also observed that there was always a varying amount of air swallowed and this was in direct proportion to the difficulty in obtaining a mouthful of milk, and this fact has always been presumed. They conclude that nipple design for human infants has always been based on the theory that milk is withdrawn from the breast or bottle by suction, well-refuted by farmers who obtain milk from cows by digital or mechanical expression. Finally the authors conclude that nipples be manufactured that are soft and pliable with the neck of the nipple 0.75 cm. in diameter. They also agree with well-known dictum that the sooner the feeding act be dispensed with the less air swallowing would occur.

### CORRECTIVE METHODS FOR AIR SWALLOWING

Obviously, the most logical step of interference with this train of events would be to prevent air swallowing or to reduce it to a minimum. To this end, many suggestions and devices have been employed.

**Mechanical Devices to Prevent Bottle Vacuum.** If a vent for the admission of air can be established in the vessel or its attachments other than at the portal of exit at which the baby is sucking, then little negative pressure can be established. Utilizing

this principle, such openings have been designed in the various types of sucking apparatus. This varies from openings blown into the bottle and guarded by a cap which is loosened during the feeding, to the many kinds of valves or small openings in the rubber of the nipple which admit air only one way (from the out-



Fig. 6. Various types of rubber nipples on the market illustrating specific vents and valves employed to prevent a vacuum from forming and subsequent air swallowing.

side) and which compensate with positive pressure through this one-way vent or opening. (See Figure 6 for some of the types of nipples designed to employ this principle.)

Illustrated in Figure 8 is another ingenious device—a flat, stainless steel disc or valve which fits into a nipple. This valve allows fluid to flow from the bottle into the nipple but prevents air from getting into it during nursing, thus preventing the nipple from collapsing. When the nipple is filled with liquid and the baby applies pressure, the valve closes and the normal sucking action extracts the fluid. Each time the infant sucks the valve opens and

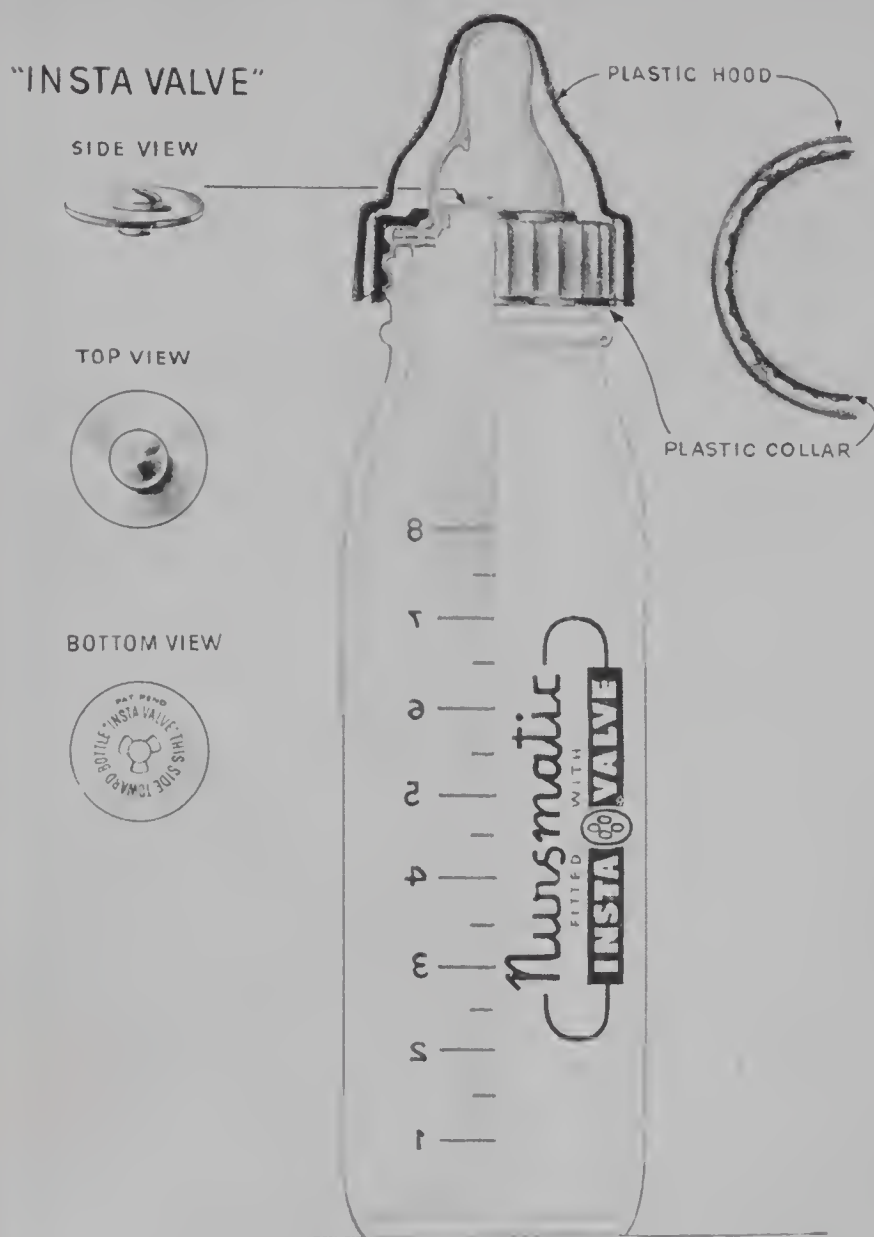


Fig. 7. Valve designed to minimize air swallowing. (a) Various views of valve. (b) Section of nursing unit with valve in place. This valve permits fluid to fill nipple, preventing a vacuum in bottle and nipple and helping to obviate aerophagia. Section of plastic hood is also shown.

the nipple refills. The *Insta-valve* as an integral part of the *Nursmatic* unit and is effective in solving the problems arising from aerophagia. It has been well received and used with marked



Fig. 8. Collapsible (disposable) plastic film nurser ("SHELLIE") simulating the mechanical collapsing principles involved in human breast emptying.

success in many infant hospital nurseries throughout the United States.

Another approach to the entire problem would be to have a collapsible bottle, obviating the necessity of having to evacuate

air from a rigid vessel, in principle the manner in which the human breast is evacuated of its contents. This has been realized by the production and manufacture of disposable and collapsible nursing bottles, coming to the mother or hospital in a sterile roll sealed from each other and merely cut off in marked places, remaining sterile until the time they are filled with formula in convenient racks (see Figs. 9 & 10). They are known to the trade as *Shellies*<sup>®</sup>. In theory and in practice, they solve the problem



Fig. 9. Plastic film nursers come in sterile packages (like gauze dressing material); are cut off in tubular segments; then fitted to a nipple device.

of air swallowing with its sequela of regurgitation of milk. The cost of the unit may be its deterrent, although including the initial outlay of equipment, each day's feeding is said to be less than five cents. Even this price may be lowered when demand and production of this equipment increase and the cost per unit is reduced.

**Enlargement of the Nipple Hole.** The most common of these helps is to enlarge the nipple hole, both to make the volume of milk delivered at each sucking effort greater, and to prevent the obstruction of the small existing hole of the nipple by undissolved

solids present in any milk mixture. The author has never seen the nipple hole that was large enough as it was obtained from the manufacturer. A further generality may be made that there is no hole that is too large in a nipple for successful feeding.

The usual story is that the baby gets tired after sucking at the nipple for 15 minutes and takes only a fraction of the food estimated for his single food consumption. The infant who is a strong nurser is not at fault, but in his avidity for food, he collapses the nipple and gets little for his efforts. With a large hole burned into the end of the nipple with a red-hot needle (one or several holes, until the liquid in the bottle fairly runs in a stream), the volume obtained for each sucking effort is much greater. The immediate complaint offered when this procedure is suggested is that the milk rushes into the baby's mouth and almost drowns him. This will happen of course, if the infant is fed while on his back, and it is natural that the gravity of the milk flow will produce this effect. Such a difficulty can be obviated immediately if the baby is held supported in the erect position so that the bottle is almost horizontal and only the nipple is filled with milk. This procedure will insure only one nipple-full at each suck-swallow which the baby can easily negotiate. In fact a hole can be punched into a nipple one fourth of an inch in diameter, and the infant fed successfully with no gagging or choking effect by merely limiting the amount of milk presented to him to one nipple-full at each sucking effort.

To the novitiate mother, it should be explained that giving a bottle is synonymous with feeding with a spoon, and requires as much care and attention. The common practice of "propping bottles" violates the major premises of good feeding habits, and is emphatically contraindicated in the newborn period.

The feeding of premature infants, and those full-term but immature babies whose sucking reflexes are underdeveloped, or whose coordination with sucking and swallowing has not been established, has always been fraught with the danger of aspiration. This hazard, of course, can be overcome by gavage. When the act of swallowing is established, inadequate intake and fatigue are factors to be considered. These can be overcome in part, by the *Breck Feeder*, but the operator may misjudge the rate at which the infant is swallowing and the incident choking and gagging

again may lead to aspiration. In a study of a number of such infants under strict supervision with the collapsible bottle by Naeff and McLendon in Washington, D.C., the impression was gained that there was less vomiting, less fatigue, and in general, the babies did better than with the standard methods of feeding.

**Eructation of Swallowed Air.** The most efficient mechanical device will not avoid some swallowed air and an effort should be made to help the infant remove this bolus. It is a good policy to hold the infant erect during and at the completion of each feeding to employ the principle of air rising to the top of any closed system, resulting in the explosive expulsion of air from the stomach universally known as a "burp," a word so common in usage that it will soon need no quotation marks to identify its slang origin. Some infants eructate air readily—those who are phlegmatic of temperament and in whom the full stomach produces a relaxed and limp, somnolent state. The tense or hypertonic infant is more resistant to the relaxation of the muscles of deglutition and of the throat, and more patience and time are required.

The successful recovery of a swallowed bubble of air usually can be gotten some minutes after the feeding is completed by raising the infant suddenly from the horizontal to the erect position. The "patting" of the back, in which everyone indulges on holding a baby and which pat often becomes a blow, does little to promote the escape of air from the stomach. (It merely gives the holder of the baby an escape for the deep and instinctive feeling that babies, when held, must be either patted or swayed.) It may induce, perhaps, relaxation incident to the security of being held. Sometimes the greatest amount of air is obtained fifteen minutes after a feeding is completed. No doubt the churning of the milk on reaching the stomach which is violently contracting with hunger waves (the noise of which so easily is heard after the ingestion of the first few swallows), produces bubbles of air akin to foam. These small air bubbles gradually break and coalesce and form a larger bubble which naturally would not have been obtainable immediately upon the completion of the feeding. A loud, resounding "burp" is still good manners when produced by an infant who has just been fed, despite its non-acceptance as conventional procedure at a later stage of his social life.

**Can Swallowed Air Enter the Intestine?** An explanation sometimes is made in statements directed toward lay parents, by physicians and manufacturers of artificial nursing equipment, that air swallowed by an infant passes from the stomach into the intestine. This is said to cause "gas in the bowel" as well as "colic," with resultant distress and excessive flatulence. It is inferred also that much of the gas (flatus) passed explosively through the rectum is from swallowed air. This theory is not warranted by the evidence at hand. Although some swallowed air may appear in the bowel, there is no evidence that a large bolus of air of sufficient size or in small quantities ever passes the pyloric ring to cause the



Fig. 10. Special nipple for use in feeding infants with a cleft palate. The rubber diaphragm helps to occlude the defect in the palate and to establish a vacuum within the oral cavity (DAVOL).

distress which is accorded its questionable presence. Air always seeks a higher level, and the path of least resistance is toward the cardia and esophagus. Gas in the intestine arises from fermentation, and is a normal product of digestion, unless produced in too great a volume. It is composed mostly of carbon dioxide.

**Cup Feeding of the Newborn Infant.** It is known that the newborn infant can be taught to take his food from a cup with little trouble, and to make nutritional gains as satisfactorily as any infant fed in the traditional manner of breast or bottle. It is the best way to feed babies with congenital oral deformities, such as

cleft lip and cleft palate. (See also Fig. 10 for infants with oral deformities.)

R. C. Freedden (55) reports an extensive experience over a 10-year period of normal infants taking food from the cup or glass from the age of 12 hours after birth. The technic is simple, according to Freedden, who states that a one-ounce medicine glass or any size of cup will suffice. The baby is merely held in the semi-erect position and the glass placed to the lips—over the lower lip and tongue—in the normal manner for drinking. Immediately, the infant begins to make swallowing gestures and regulates the flow of milk into the oral cavity by mouthing movements, involving mainly the lower jaw. The feeding can be dispensed with in five to 10 minutes. It has been used very successfully with premature babies whose sucking capacity is minimal. In all premature infants fed in this manner, the weight gains made compared favorably with those of the 59 others in the series who were fed by the breast and bottle.

The immediate objection made to this type of feeding is that the decreased sucking experience in the early months of life may produce more frustration, and may employ the denied gratification of sucking in some perverted form, such as thumb-sucking. Freedden has the impression that far from being frustrated, these infants adjusted to the usual childhood experiences with great ease, and that there were no larger number who became *thumb-suckers* than in a group fed in a traditional manner. He states that the transition to taking solid foods later was made more easily, and the psychological benefit of being held in the mother's arms eliminated the impersonal aspect of propping a bottle, and more than overcame any frustration due to the lack of expressing the sucking instinct.

H. V. Davis, *et al.*, (43) divided 60 babies into three groups of 20 each, one group being fed from the breast, one from the bottle, and one from the cup during the first 10 days of life. There were no statistical differences in weight gain, amount of oral activity, or crying. They state that it is presumptuous to assume that the *oral drive* in a baby is innate rather than acquired. The psychological premise that infants have a *sucking drive* in addition to a sucking reflex, and that this drive must be satisfied, has not been proved.

Their study does not give any final solution to the problem, but indicates the need for further observation of an enigma on which so much has been written and so little completed experimentally.

### MILK FORMULA STERILIZATION

Recently, *Terminal Sterilization*, which has long been employed in the preparation of milk mixtures in the milk rooms of hospitals, has been introduced into the family home-procedure of sterilization of the infant's bottled milk supply. It is recommended by the Committee on Infant Feeding of the American Hospital Association, by the American Academy of Pediatrics, and by an increasing number of health authorities and pediatricians. Just why this procedure has not been utilized in the home sterilizing of formula preparations in contrast to the conventional *Aseptic Technic*, is not quite clear, unless it is because the type of bottles and nipples required were only recently available. (Hospitals usually employ the pressure method by autoclaving [15 pounds of pressure at 250° for five minutes] to insure complete asepsis.)

**The Aseptic Technic:** By this method, the nipples, bottles, caps, and all utensils are first washed and then sterilized by boiling (212° F.) in an open vessel or in a sterilizer for 15 minutes by steam. The formula is prepared and poured into the sterilized bottles which are then closed by the sterile caps or nipples with appropriate covers, ready for the refrigerator until needed. The sterile nipples are applied at feeding time. This technic presents opportunities for contamination or a break in the technic when the formula is poured into the bottle and again when the nipple is placed on the bottle at the feeding time.

**The Terminal Sterilization Technic (non-pressure method):** By this procedure the bottles, nipples, and covers are washed. The formula is prepared and poured, before sterilization, into the unsterilized bottles. The nipples are applied to the bottles in the feeding position, and a shield (cap or cover) is placed over the nipple in a manner that will permit exposure of the nipple to the sterilizing medium (steam). The completed nursers are then placed in the sterilizer and all treated at one time by steam for 15 minutes (212° F.). After sterilization, the shield is forced down, which seals the formula and the nipple. By this method, the

nipple and bottle contents are sealed and untouched until the moment of feeding, eliminating the possibility of contamination and break in technic.

Various studies have been conducted as to the efficiency of *Terminal Sterilization* on the physical condition of the milk mixture, as well as on the bacterial count with appropriate controls. In one of these (conducted by the Borden Company on a formula of *Borden's Evaporated Milk*, tap water, and *Karo Syrup*<sup>®</sup>), employing the Standard Methods for Examination of Dairy Products of the American Public Health Association, the following results were found:

1. No bacteria—with formula left in sterilizer at 80° F. for 24 hours.
2. No bacteria—with formula refrigerated at 40 to 45° F. for 24 hours.
3. Controls under both conditions in unsterilized bottles of the same formula contained up to 372 million per cc. in unrefrigerated bottles, and 31 organisms per cc. when refrigerated, both after 24 hours.

### Changes in Milk Mixtures with Terminal Sterilization

In the questionnaire results from the manufacturers of all of the substitute infant milk foods listed in Chapters 5 and 6 regarding the effect of terminal sterilization on any specific food or additive, it will be found that none is adversely affected except the *Lactic Acid* and *Protein Milks*. Some of the products assume an amber or tan color but there was said to be no effect on the chemical quality of any of the products except those stated above.

It will be noted that many of the manufacturers of proprietary-named products make much of the natural or added presence of various specific nutrients and yet some of these, *vitamins A* and *C*, *thiamine* and the amino acid *lysine* are well-known to be heat labile and thus would be destroyed at the temperatures obtained with terminal sterilization. In a comprehensive review of the effects of heat processing of milk, Heineman (73) points out the relative stability of many of the nutrients and protein derivatives under temperatures required to sterilize milk. Smith *et al.*

(162) establish the fact that sterility tests on formulas processed at 230° F. for 10 min. have been adequate for the terminal heating of infant formula. Hodson (76), working under the direction of Heineman and Louder at the Pet Milk Research Laboratories found that infant formulas which received the prescribed low pressure terminal heating had an average retention of 95 per cent of the ascorbic acid, 91 per cent of the thiamine, and 100 per cent of the lysine. He states "In view of these small losses of the 3 relatively heat-labile nutrients, there is little reason to suspect that any significant loss of the more heat stable nutrients of milk occurs during terminal heating of infant formula by these methods."

### **Single Bottle Sterilization Method**

The ideal procedure in sterilizing infant milk mixtures has always been to compute the quantity needed for one 24-hour period and to sterilize this feeding quantity followed by refrigeration. With modern dependable home refrigerators it is conceded that a 48-hour number of bottles may be prepared, and if kept cold to inhibit any bacterial growth and if adequate room is assured in the refrigerator, no decomposition or deleterious changes will occur which would be harmful to the product or infant digestion. The reasons for preparing a given quantity for a number of feedings are obvious: it assures constancy of the various amounts of the ingredients, there is a uniform diluent in each bottle if compounded correctly; it facilitates accurate observation of the digestion of the mixture since one or even five bottles or more of feedings would be required to make any kind of observation of the efficacy of any change made; and also it is more economical in time and work to make up a number of feedings at one time.

Where refrigeration or ice-box facilities are not available in homes of lower economic groups, or perhaps where only one or two bottles or nipples can be afforded, the problem of keeping relative sterility or even bacterial stasis at a minimum becomes a constant hygienic threat to any feeding mixture. To solve this dilemma, Dr. Stuart W. Adler of Arizona has presented a practical but precarious solution, at least a less hazardous risk than to have the entire formula mixture become contaminated by lack

of cooling facilities. He suggests that water hot enough to temporarily render the bottles and nipples hygienically clean is most always available. By scalding the nipple and bottle in boiling hot water and promptly filling it with the newly-made milk mixture, calculated to one feeding, will minimize the chance of bacterial changes. The mixture in the bottle is to be immediately consumed by the baby and the remainder discarded. Since *time* is the factor in bacterial growth especially in milk as a medium from time of production or mixing until consumption, then this time factor is lessened and bacterial growth with resultant decomposition is inhibited. See the *Journal of Pediatrics*, June 1959, for elaboration of this theme in discussions by Gibson, Fischer *et al.*, Foman *et al.*, and the sage editorial views by Dr. Lee Forest Hill.

### INGESTION OF COLD MILK MIXTURES

In early 1958 a paper appeared in one of the reputable and leading pediatric journals (64) which attracted the attention of many special feature writers of newspapers, and it had its echoes into the consulting rooms of physicians over the country who see and direct the feeding of well babies.

The physician author reported a study of 150 infants in his practice as to the acceptance rate of milk mixtures directly from the refrigerator (or "after the chill had disappeared by standing at room temperature"), the effect on weight gain, and as to any harmful results from the taking of cold formulas. The acceptance rate was about 50 per cent for the young infants and 75 per cent for the older ones, with an over-all rate of acceptance for cool and cold feedings of 89 per cent. All weight curves were consistent with the average before and after the changes to unheated formulas; development proceeded normally, and there were no apparent harmful effects traceable to the use of cool or cold formulas. In a special note the editors of the journal commented that the findings or concepts presented in the paper did not necessarily reflect those of the journal's editorial board but the paper was accepted because they admired the intellectual curiosity of the practitioner who made the observations. The reason for discussing this unusual article here is that it received so much publicity in the press (as do all deviations from the conventional) and

deserves to be observed in the light of scientific data available.

There are other reasons for warming infant milk foods than custom and propriety. It has been estimated that one mother warms over 1400 bottles of formula during the first months of a baby's life and it is therefore justified to evaluate this procedure if it merely represents gesture and convention alone.

The technical reasons for warming milk mixtures for infants are as follows:

1. It is an acceptable and proven physiological fact that the ingestion of food at less than body temperature delays the emptying time of the stomach, emptying time *per se* being one of the acceptable indices of ease or difficulty of digestion of any food.

2. Optimum *ptylin* (starch enzyme), *rennin* and *pepsin* (casein enzymes) activities, which occur in the stomach, are known to require body temperature (98.6° F., 37° C.) in vivo and in vitro.

3. As it pertains to infants, it is known that before gastric digestion can begin, the stomach contents must assume body temperature. When this is required of cold food in the stomach, the heat is derived from the infant's gastric circulation by conduction and radiation and hence from general body heat. Thus, calorie energy, otherwise used by the infant for anabolic processes, is dissipated uselessly in warming the gastric contents. In premature or clinically immature infants this procedure would be a useless loss of energy by an organism with already-well known problems of thermal control and weight gain. In some unpublished observations made by Brennemann in eurd studies, it was observed that milk mixtures given at room temperatures (72° F., 22° C.) remained in the stomach as long as 5 hours after ingestion. The same mixtures given at body temperatures left the stomach in 3 to 3½ hours. It could be assumed that milks at refrigerator temperatures (40° F.) would delay gastric emptying time even longer than 5 hours.

The reader of this section is left to his own judgment in weighing the decision as to the propriety of warming refrigerated milk mixtures for infant consumption based on accepted scientific evidence, or whether it is part of a general movement of minimal versus optimal infant care which is evident today in the general modern infant culture. (See Chapter 10.)

## *Chapter Eight*

### SOLID FOOD SUPPLEMENTS OF THE FIRST YEAR

**T**HERE IS perhaps no current problem in clinical infant feeding so controversial as that of the introduction of semi-solid foods to the infant dietary. This subject is dealt with in this section more extensively than would be warranted if it were not for the fact that it is currently more in the lime-light than any other in the field of practical infant feeding. There are those who take an extreme view on either late or early introduction of these foods, and there are those who take a middle-of-the-road position—each justifying and defending ably his respective premise. All positions are here presented and the reader may decide his own point of view. In the light of these divergent opinions by equally excellent authorities, it is with sympathy and compassion that one regards the confusion of the neophyte in pediatrics, and equally those who have been trained in the school of authoritative dogma. Nowhere in the field of infant feeding will the dilemma be greater or the burden of choice more prodigious.

#### OPINIONS IN THE LITERATURE

During the past 4 years, at least 15 articles dealing with the subject of adding solid food to the diet in the first year of life have appeared. Six of these approve of, or are tolerant to, the early feeding of solids before the 3rd or 4th month of life, and they present facts in favor of their premises. Nine either condemn or question this procedure.

Deisher and Goers (46) report a group of 40 infants who received only breast milk or milk formula mixtures with supplementary vitamins for 3 months, and a control group of 45 infants which had solid foods added during the first month. Both groups were examined regularly throughout the study. In both units there was a comparable number of illnesses during the first year;

the number and character of the stools were not different, nor was the amount of so-called "colic", excessive regurgitation, or night awakening more frequent. There were no dissimilarities in the red blood counts or hemoglobin estimations of the 2 groups; and the rates of growth and numbers of food refusals were not distinctive.

Sackett and Sheppard (147) and Sackett (146) fed babies solid food beginning on the 3rd or 4th day of life for the last 3 years, and on a 6-hour schedule. On this routine the midnight feeding was discontinued as soon as possible, leaving the baby on 3 meals per day. Over 300 neonates have been observed on this regimen, and are said to have taken to new foods more readily, had fewer bowel upsets, seemed more contented, and had a smaller number of allergic reactions. They also followed closely, and sometimes surpassed, the physical standards set by babies on a more conservative routine. A more detailed study is now in progress.

In a report suggesting earlier administration of solid foods, Gough (67) has devised a system which introduces orange juice and cereal in the first 7 days, fruit at 12 to 14 days, and meat and vegetables by 21 days. The author states that these infants gained weight more quickly, appeared to be less fat and "flabby" than when fed a sole milk diet, and that they were far less prone to develop feeding problems.

Richmond and Waisman (140) state that meat protein, according to a recent study, is as effectively retained and utilized as milk protein by premature infants, but they question whether it is an improvement on the present clinical practice of supplying iron and vitamins to the milk-fed premature baby.

In summarizing the nutritional requirements of infants, Stearns (166) finds that all specific nutrients (except vitamins C and D), calories, phosphorus, sodium, potassium, calcium, protein, and water are met when the full-term infant receives 2 to 2½ oz. of human milk, or 1½ to 2 oz. of cows' milk per pound of body weight. "Additions of foods containing iron and thiamine are desirable by 3 months or soon thereafter."

Concerning supplements to the milk diet, Jackson (88) states that: "Although nutritional knowledge has increased rapidly, there is evidence that our present knowledge is still incomplete. Nutritional essentials now unknown, undoubtedly exist. It is

reasonable to believe that they are more likely to be obtained from a mixed diet than from one more restricted." He states further that there is an advantage in giving sieved vegetables and fruits early to provide variety and texture.

Writing on the subject of "So-called 'Progress' in Infant Feeding," Peterman (123) makes the point that, "Those of us who learned the physiology of digestion first, particularly in infants, have been amazed at the changes in infant feeding during the past 25 years". In this age of progress and modernization "the physiological facts of digestion in infancy have not been modernized or changed . . . the average well-fed infant will thrive best on breast milk or a modification of cows' milk for the first 2 months of life. . . . No one has demonstrated any need for food supplements at an earlier age. . . . The competition between parents should not be carried to gastronomic achievements of their offspring."

In place of emphasizing the digestive reasons for delaying solid foods, Bakwin (110) varies the approach by calling attention to *mechanical* factors involved. He says that very young infants push with the tongue against the spoon, or against solid food placed between the lips. At about 3 or 4 months, when solid food is brought to the mouth, the lips part, the tongue carries the food to the back of the mouth, and swallowing follows. Three to 4 months is the optimum time to begin solid food supplements, and nothing is to be gained by earlier administration is his conclusion.

Milton J. Senn (154) deplors the "trends" in streamlined child care, including that of having the infant give up the 2 A.M. feeding before he is ready for it, introducing solid foods by the 6th week, and arbitrarily scheduling the infant on a 3-meal-a-day routine by 3 months. Thus chronologic age is the guide post in each instance, rather than a physiologic need. Some parents want their babies to be miniature adults, and attempt to hasten their development through infancy.

Barnes (14) points up still another tangent against early feeding of solid foods. "After all, milk is the one indispensable food during infancy. Let us not harry and overwork a busy young mother by making extra work for her. The 3rd or even 4th month is soon enough for addition of solid foods." [*It is doubtful whether most*

*young mothers would appreciate this solicitude in their behalf when their leanings are so strongly toward early variations.]*

In attempting to shed some light on this "chaos of confusion," Meyer (111) admits the many vagaries of physicians in adding solid food supplements, rejects *age-in-months* as the criterion, but stresses *individual* infant needs. In this paper all of the foods usually added are defined and described in detail from a chemical and nutritional viewpoint and function. It is suggested that each infant's requirements be weighed on an individual basis.

Watson (178) believes that it is unnecessary to begin supplementation before 3 months of age. He senses a kind of popularity contest ensuing between mothers of young babies—each claiming that her own doctor is more modern and advanced because he begins supplementing the baby's milk formula at 2 months, or even at 1 month of age. "There is room for individualization here, as there is at all periods of childhood as far as feeding is concerned."

All of these conflicting and divergent arguments add to the confusion of the doctor, who desires to establish a plan of procedure in his own practice, which might be scientifically and nutritionally sound.

### MASS SURVEY RESULTS VERSUS NUTRITION FORUM OPINION

In order to shed some light on this seemingly conflicting nutrition problem, Dr. Allan M. Butler and Dr. Irving Wolman (21), through the medium of the *Quarterly Review of Pediatrics* of which Dr. Wolman is editor, inaugurated a pioneer adventure in medical journalism—that of a forum discussion based upon mass surveys conducted by means of questionnaires. Over 2,000 returns were obtained, an unusual response in this kind of fact finding. These data were analyzed and the results submitted to a group of authorities in the field of infant nutrition and welfare. The results of the questionnaire and the full discussion by the Forum members are found complete in the May 1954 issue of the *Quarterly Review of Pediatrics*.

*Survey Data.* It was established that 96% of the pediatricians have begun solid foods before the 3rd month as the very earliest time, but 88% routinely begin before the 3rd month. More than

twice as many physicians, who have been in practice less than 10 years, start foods earlier than do those in practice over 20 years. Both of these facts are significant, and will be discussed later. About 60% of the doctors questioned stated that they found that most mothers insist on early addition of solid supplements. The most common first food is a single grain cereal (64%); while the 2nd solid food added (41%) is fruit. About 72% of the answers contained the information that there was no increase in food sensitivities in the last 2 years. Of those who were impressed that there had been an increase of food allergies (22%), it was interesting to note that the symptoms which they thought pointed to this sensitivity were referred to the gastrointestinal tract as evidenced by diarrhea, vomiting, "colic," and constipation; while the 2nd most common system effected was the skin (eczema, rashes, urticaria etc.). *[The ability to arrive at a correct diagnosis or impression would vary so considerably in reference to the specific training of the individual physician that these observations are open to question more than any other of the queries of the poll.]*

*Forum Opinion.* The 12 participants in the Forum on the evaluation of the questionnaire were selected because of their special status as nutritionists, or as authorities in infant feeding or child care. They were asked specifically to comment on the major factors which underlie the current trend to earlier feeding of supplemental foods, as indicated by the survey; and what nutritional benefits and disadvantages were to be gained by early addition of solid foods. One is impressed in reading the original article of the sincerity and intellectual honesty of the opinions rendered. The conclusions were almost unanimously *against* addition of solid foods before the 3rd or 4th month, and each discussant supported his premise by experienced opinion or scientific reasoning.

Certain excerpts of the Forum participants, admittedly quoted out of context, are given here which are indicative of the general tenor of the discussion:

"... a reflection of current parent reaction to all types of restraint. . . . Competition and keeping up to the neighbor's baby play an important role."

"The practice of early feeding of solid foods is not advocated

in pediatric text books nor recommended in current medical journals."

"If the baby is satisfied and thriving, I see no advantage in adding cereal before the 4th month and then not in large amounts."

"No important nutritional benefits are to be gained by adding solids under the age of 3 or 4 months except in infants who vomit easily."

"The feeding of solid foods with their considerable ash content, under certain conditions, increases the risks (renal solute load for excretion) in the feeding of young infants."

"Theoretically, the early addition of solid foods might precipitate celiac disease or other complications. However ill effects . . . should be obvious in pediatric clinics by now, and this is not the case."

"Adequate scientific information can not be presented to demonstrate superiority of supplemental feeding of solids early in infancy over feeding of acceptable milk formulas alone."

" . . . the major factors underlying the current trend to earlier feeding of solid foods are more probably social than they are nutritional or medical."

"The greatest disadvantage of very early feeding addition of solid foods would be forcing them upon an infant before he was developmentally and psychologically ready for them in the belief that they were nutritionally necessary."

The only mitigating opinion which prevented the persuasion of the members of the Forum from being unanimously *against* feeding infants solid food before the 3rd or 4th months was that of Dr. Stewart E. Clifford:

"In my opinion, the trend (of early solid food supplementation) is in part the result of demand feeding and the principle of self-selection of diet. The babies *like* solid food; it has a high caloric content for its volume; they are more contented, take less milk and fewer feedings, and place themselves naturally on 3 meals. *Everyone concerned likes this.* Theoretically, the solid diet gives the infant a wider choice of protein and minerals than does a milk diet. Practically, the infants thrive and have more solid tissue and less anemia than on a plain milk diet. . . . The practice of early feeding of solid foods is so universal that ill effects should be obvious by now in pediatric clinics and, as far as I know, this is not the case."

The consensus of the Forum members inferred that the foods given to infants today are largely *hypo*-allergic because they have been subjected to heat in their preparation. One essayist offered the suggestion that *decreased* food allergies may result from the early and pronounced rotation of foods, instead of the feeding of a single food substance (milk) for a long period of time.

Dr. C. A. Smith, in commenting on this subject in another place (161), made the statement not-too-facetiously that "Perhaps the warning is needed that one such question which could someday require a decision in some maternity hospitals, though it has not yet reached the writer, is the spoon-feeding of semi-solid foods to extremely young infants." One can only conjure the mountainous problems this would entail in the present-day central nursery system of the average American hospital maternity department!

#### AUTHOR'S COMMENT

The concept that the manufacturers of fortified cereals, strained vegetables and fruits, pureed meats, and canned egg yolks should have been influential in formulating the opinions or feeding customs of modern physicians is highly improbable. These food products prepared for the infant consumer, are more constant and reliable than trusting to the culinary skills of some modern mothers. It is doubted that convenience and availability play much of a role in the prescribing of the physician. These commercial preparations have *followed* a need and have been *provided* by industry, rather than to suppose that the pediatricians have been led by the enterprising marketeers. The *supply* was produced when the *demand* was demonstrated.

Equally specious is the argument that many physicians are influenced by the pressures, hopes, or ambitions of the mothers in competing with their neighbor's babies. Nor are many mothers seriously impressed by the so-called "scientific advancement" of any physician whose skills lie in the realm of making an impression on the parents of the children in his practice. There are, no doubt, some (younger) physicians who are forced to add foods for which there are no need, just as they think that they compulsively must treat every minor cold or loose stool which an infant may have or of which a mother may complain. These medical advisors

seem to withdraw from the excellent opportunity to propagandize parents in the truths of modern child culture. They only feel secure or adequate when they are armed with a prescription blank or fortified behind the security of a diet slip so that they may "add something new." Many seasoned, and some intellectually honest younger physicians, after examining a baby, may leave the milk mixture as it is and add nothing new to the diet, without feeling inadequate. These opportunities are to be desired by the modern doctor who enters into other than the physical development of his young patients. The physician will find that most parents are more than receptive to directives in minor problems and parental attitudes of child care, and that he need not always prescribe medicaments or change something in the diet to impress them. Any neophyte dealing with the parents of children who evades these opportunities is either inadequately trained or is not sure of himself or his ideals.

It seems reasonable that both viewpoints of these divergent opinions of early or late solid food supplements, can be compromised and still stay within the precepts of scientific integrity. In the Forum discussion, Dr. Weech stated a fact concisely when he said of the questionnaire results that: "Scientific truth is not established by taking a vote, no matter how democratic the procedure." The poll's chief value lies in the fact that it is merely a reflection of the practices and customs of a representative number of pediatricians in this country. Those members of the panel are correct when they state many times, and in as many different ways, that there is no nutritional need for early supplementation of *all* milk-fed infants. It is admitted, too, by the members of the Forum that there are still many lapses in our knowledge of nutrition requirements. Since no demonstrable harm has been proven by the early addition of solid foods, it would be wise to accept the sagacious summary of Dr. Charles May "If none of our opinions or prejudices are pursued too energetically, the majority of our infants will thrive in the face of the imperfections in our knowledge, and we should be able to attend to the task of accumulating further information without engaging in heated debates on personal opinion." (21)

It would seem then, that the watch-word in pediatrics and in

modern child education, which has been constantly stressed, is that of the *individuality* of the infant and child. Instead of issuing dicta to the effect that infants should be fed solid food at so many *weeks* or *months*, the *need* of *each* infant should be considered, rather than engaging in generalizations and platitudes. Certainly, a premature infant weighing 3 or 4 lb. at birth will not necessarily be able to ingest solid food at 2 months or even at 4 months when the weight may probably be only 8 or 9 lb. This immature baby may be far behind in motor skills employed in eating, and may often be deficient in digestive abilities. In the same vein, the large, husky, and mature baby weighing 8 to 10 lb. at birth, who is constantly demonstrating evidences of his motor coordinations and food needs, should not be held to some conventional dogma of no additional solid foods until 4 months, when his obvious requirements are evident. A far better indication for solid foods would be the individual infant's requirements as estimated by development and growth, and these to be determined by the physician directing the care and feeding of this infant. For the beginning physician, a directive of *poundage* would be a better guide than *age*. Thus a baby weighing 12 to 14 lb. would likely be in need of additional sources of iron, protein and perhaps calories, as well as an exercise for his newly-acquired motor skills of tongue movements and of deglutition—despite his age in weeks or months. *Weight* and *development* would compromise much of the controversy now existing, rather than *chronological* generalities.

#### COMMITTEE ON NUTRITION—AMERICAN ACADEMY OF PEDIATRICS

This subject is involved in so much controversy that it is deemed important enough to have an official pronouncement by an authoritative body. We have such an opinion available by the Committee on Nutrition of the American Academy of Pediatrics in a special report "On the Feeding of Solid Foods to Infants" in April 1958. (33) Until further research and metabolic data are available, it would seem appropriate that this final word will suffice until that additional information is available. Here follows the recommendations of this Committee:

"The Committee on Nutrition believes that some specific ree-

ommendation regarding the optimum time for introducing solid foods into the infant's diet might serve a useful purpose, especially for pediatricians who are under pressure to recommend solid foods early. With this in mind, the following statement has been prepared.

Normal full-term infants can be expected to thrive for the first 3 months of life on human milk or a properly constituted cows'-milk formula. Supplements of a minimum of 400 units of vitamin D and 30 mg of ascorbic acid should be provided.

Iron-containing solid foods should be introduced during the third month. . . ."

"The Committee is in agreement with those who object to the use of age as a rigid standard. It believes the needs of infants are best served on an individual basis. Large, rapidly-growing infants consuming large quantities of milk, yet obviously hungry, may be made contented by reasonable concentration of the formula or by supplementing with cereal or meat at an age earlier than 3 months. On the other hand, small premature infants may not be considered ready for solid-food additions even at 3 months of age. Likewise, ill infants and those with special problems, such as sensitivity to milk, merit individual attention.

On the basis of present knowledge, the Committee is in agreement that no nutritional superiority or psychologic benefit results from introduction of solid foods into the infant diet prior to 2½ to 3 months of age."

#### OUTLINE AND DESCRIPTION OF THE CONVENTIONAL SOLID FOOD ADDITIVES

In order to orient the reader as to the reasons for the foods which are offered to infants in the first year, all of the usual non-milk-bottle-fed foods usually supplemented are presented here with a brief reason for their inclusion. The definition of these foods is arbitrary as here discussed but most have scientific and laboratory-proven reasons for their uses, albeit the times of their inclusion in the infant first-year dietary is still highly controversial. Possibly the following presentation as to their nature will help the reader to define for himself when they should be added to the diet of the first year.

## Cereals

This type of solid food has long been the favorite 1st solid food to be supplemented to milk, even though there is no deficit of carbohydrate at this age. There are many other foods which could be added that have a more scientific rationale. Many doctors defer the feeding of cereals until well into the last part of the 1st year, and supply 1st the foods like vegetables and fruit, which contain the immediate requirements of metabolism and growth.

However, since the advent of the whole grain, mineral and vitamin fortified commercial infant cereal foods, this type of supplement may rightly again take its place at the head of the list. The "pre-cooked" feature of these cereals is of practical advantage to the mother as a time-saver; but the greater advantage lies with the infant, since the starch is made more available in pre-cooking than when entrusted to the variations of some mothers' culinary efforts. Other advantages of these cereals are: they are smooth and finely divided; the diluent of milk lends to them a familiar milk flavor; and they are easily manipulated by the infant to the back of the throat by the tongue, thus creating a favorable impression on the infant in his 1st experience with solid food.

There are 6 manufacturers of these pre-cooked cereals. The starch is obtained from poly-grain origins such as wheat, barley, rice, oats and corn, and from the dried fruits of the tapioca and papaya plants. They contain, in addition to the starch, non-fat milk solids, dried brewer's yeast, wheat germ, bone meal, alfalfa, reduced iron, dicalcium phosphate, calcium carbonate, sugar and salt, and thus provide varying but more than the minimal requirements of the vitamins of the B complex and essential minerals. They are marked improvements to the traditional, long-cooking, home-prepared cereal preparations of wheat, oats and barley which were for so long the only available cereals to be had. The latter may be used from time to time for any infant to acquaint his palate with newer sensations and tastes.

## Vegetables

These "natural" sources of iron and vitamin B complex are logically the 1st foods which supply a primary need. As has been known, the liver of the infant stores sufficient iron from the

hemoglobin breakdown after birth to supply a 4 to 5 month post natal period. When this supply is depleted, it naturally follows that some extraneous source should be supplied to the infant diet at this time. Since the custom of the addition of vegetables and fruit early in this period has become common practice, many of the so-called "milk anemias," so patently accepted in old pediatric texts as normal phenomena, have been largely eliminated. (See page 198.)

The home-cooked and poorly strained vegetable preparations have been antiquated in recent years by the availability of the canning industries' products, now well distributed in this country. These are more effective when used for infants than the home-prepared product. These commercial products are more finely strained, they are more uniform in mineral and vitamin content, and their pre-cooked states assure the infant consumer a constancy in mineral and vitamin content, without the over-cooking deterioration which may obtain in the domestically prepared product. All of the vegetable and the vegetable-starch-meat combinations are sources of calcium, iron, thiamine, riboflavin, niacin, vitamins A and C, and other specific nutrients in appreciable amounts. The availability and inexpensiveness, to say nothing of the convenience, are noteworthy of comment, especially in urban areas.

### **Fruits**

All that has been said of the vegetable additions is true of the fruits as well, being interchangeable with vegetables as to need. The fruits contain variable amounts of iron, copper, phosphorus, as well as the vitamins A, C, and components of the vitamin B complex.

### **Egg Yolk**

This vital addition to the infant's diet contains unusually large amounts of calcium, phosphorus, iron, thiamin and riboflavin. The iron in egg yolk is 7.2 mg. per 100 Gm. which is higher than in comparable amounts of liver or beef, and each egg yolk provides 56 calories. Egg yolk may be administered to the infant either cooked (soft or hard boiled), or raw in either cereal or milk. There is also a liquid egg yolk preparation commercially canned which is approved for infant consumption.

## Meats

In the last ten years there have been at least 8 reports in the literature on the effects of early administration of meats to infants, including premature babies. Leverton and Clark (96) in 1947 fed meat supplements to a group of 15 infants to determine its acceptability and tolerance, as well as the effect on hemoglobin and red cell values. The hemoglobin increased 10% to 13% in the meat-fed group compared to a loss of 4% to 10% in the control group. No attempt was made to ascertain or state which factor in the meat was responsible for the improvement. Sanford and Campbell (148) gave desiccated beef to 102 infants at 1 to 2 weeks of age. Weight gain was identical in both groups, the meat supplement maintained the concentrations of red cells and hemoglobin as well as did the group receiving iron orally, but they found no difference in the blood picture of the meat-fed and control full-term infants in the six and 12 month periods during which they were observed. In other studies (159, 5), inferences of an advantage in the meat-fed group have been published. On these observations the Committee on Nutrition of the American Academy of Pediatrics had this to say (33): "Strained meat has been shown to be the equivalent of milk as a source of protein, and to be well-tolerated by both premature and full-term infants. Claims for the advantages of the early introduction of meat are conflicting (*in regard to augmenting the production of erythrocytes and hemoglobin—author's italics*) and do not permit the drawing of definite conclusions."

At present, the time to add meat to the baby dietary, varies markedly. It has been fed to the premature infant 1 week old, and is said to be routinely prescribed by physicians for babies at 4 months or earlier. The commercial preparations offer strained liver, beef, veal, heart muscle, lamb, chicken, ham, pork and combinations with bacon. The economy of these products is an asset, since it takes 6 oz. of beef to yield 3½ oz. of cooked scraped beef at home; 10 oz. of veal steak to yield 3½ oz. cooked strained veal; and 16 Gm. of complete protein is provided to each 3½ oz. of commercial can or package. Fruit flavors (mint, apple and raisin) have been added to some meats to "improve infant acceptance."

McQuarrie *et al.* (103, 104) used strained meats as the basis for formulating a milk substitute for babies who were allergic to, or for some reason, did not consume adequate quantities of

milk. Studies with this milk substitute "indicated that the calcium-supplemented meat diet was equally as good as a milk diet as a source of Ca, P, and protein." The quantities shown in this formula to follow furnish approximately the same amounts of protein, calcium, phosphorus, fat and CHO as a pint of whole milk.

COMPOSITION OF A MILK SUBSTITUTE  
(McQuarrie, *et al.*) (103)

Strained Beef.....	100.0 gm.
Salt Mixture (Ca-gluconate, 6.3 gm.; $K_2HPO_4$ , 1 gm.; and Mg-citrate, 0.4 gm.).....	7.7 gm.
Lard.....	16.5 gm.
Rice.....	16.0 gm.
Sugar (Sucrose).....	12.8 gm.
Water.....	347.0 cc.
Total.....	500.0 gm.

A similar meat-base substitute was conceived by Rowe (144) for use in an elimination diet for determining food allergies for infants, and forms the basis for one of the hypo-allergenic bottle-fed infant foods *Gerber's Concentrated Meat Base Formula* (See Table 23).

### Fish

This item is an excellent addition for nutrition reasons and has not been included in the infant dietary until recently, apparently because of the obvious foreign body hazard. Strained tuna fish is now available for babies and should be introduced to the young infant when meat is added. Fish is especially high in protein with 10 or more of the amino acids freely available in the product. It is low in fat, high in phosphorus, iodine, fluorine, and a rich source of vitamins A, B, D, and animal protein factor  $B_{12}$ .

### Whole Egg

The time when the whole egg is added to the infant's routine is much varied by practicing physicians. The white or albumin adds little to the nutritional value except additional protein (about 3 Gm. per egg). However, since the whole egg will become part of the general diet at a later time, any period would be suitable from a nutritional point. In suspected sensitivity, the

allergenicity of the egg white and the yolk should be determined separately. The whole egg may be offered as a "coddled" egg (3 minute cooking to the point where the white is still liquid), or "scrambled" later in the 1st year when the infant has become accustomed to the gustatory sensation of bulky or coarser foods.

### **Puddings**

These are concoctions basically of starch, derived from corn, rice, wheat flour or tapioca mixed with milk and egg; enzyme and flavor containing powders added to whole milk, precipitating the curd *in vitro*; or gelatine preparations with an added carbohydrate and with true or synthetic fruit flavors added. The 1st serves as a vehicle for both egg and milk in the diet, while the 3rd is essentially the incomplete protein known as gelatine, with added dextrose. All of these puddings may be made in the home, or may be had in the canned or packaged commercial preparations ready to be eaten. These foods serve mainly as desserts to educate further the taste experiences of the infant, to provide an easy source of calories, and as a medium for the ingestion of milk or egg if this happens to be a dietary problem.

Ice cream, which may be classed as a pudding, may be added as a dessert in the last months of the 1st year despite the unfounded prejudice against it. It is high in fat and carbohydrate (12% and 20%) but coming after other food at mealtime, it is well tolerated. Because of the high fat content and the coldness, it slows down the emptying time of the stomach, but following other foods these effects are neutralized. Ice cream should not be given between meals for the reasons just stated.

Banana also may be classed with puddings since it resembles them in composition. It is low in fat and protein but high in carbohydrate (23%), mostly mono and disaccharides. Its use in the celiac and diarrheal diseases has been well established, and it is well tolerated and received by normal infants. It is now available in the canned commercial packages, which is smoother than the mashed fresh fruit.

### **Non-Cereal Starches**

The addition of these foods is made late in the 1st year as a substitution for the cereals of which the infant often tires. These include: potato, macaroni, noodles, rice, spaghetti, hominy and

bread. All are 7% to 14% protein, little fat, and 70% to 80% carbohydrate, almost pure starch. Usually the infant resists this form of starch food because of its colloidal or glutenous texture in the mouth. By repetition and patience, the introduction to this ubiquitous food item of his later life, will be made eventually.

### Dairy Foods

Cheese is an important item of diet for the older infant. It serves as an excellent source of easily digested protein. Cottage cheese has 19% protein and little or no fat or carbohydrate. Other natural and processed cheeses are high in fat and also in protein. They may be offered alone in the hand to chew, in combination with starchy foods, or with raw vegetables in a salad.

Butter and oleomargarine are identical as to chemistry and calories. They are added to foods for seasoning or flavoring, and on bread as an adjunct to the complete meal. Oleomargarine contains vegetable oils instead of animal fat and for this reason is digested as well or better than butter. Its economy provides any infant with an inexpensive, easily digested and pure source of the necessary fat intake.

### Chewing Foods

As soon as the infant has coordinated the grasping reflex with the hand-to-mouth movement, this may be exploited to the 1st step of self-feeding. These so-called *chewing foods* include: dry toast, Zwieback, bread crust and Melba toast. Later, crackers and sweetened cookies may be added. These foods offer little nutritionally, but they serve a purpose in instigating interest in self-feeding. With flavor as a factor, they have the advantage over the tasteless teething rings for soothing the gums.

### Unstrained Foods

Anytime after the 6th month babies should be offered foods which have not been strained, to accustom them toward the act of mastication. Infants vary considerably in this skill, some being able to manage gross pieces of food after the incisor teeth have erupted, while others regurgitate on an awareness of only small particles. One is impressed that temperament and an innate laziness are prime factors rather than a "small throat" or a defective swallowing mechanism, as the parents readily imply.

However, if needed, the concession of strained food should be

made to the baby until after the 1st molar teeth have erupted, since these are really the 1st grinding equipment with which to chew. After this time, only grosser foods should be offered and no other—until hunger overcomes this infantile regression.

### **Raw or Uncooked Foods**

The advantage of raw vegetables or fruits has been overextolled by the food fadists. The raw foods offer little more than the cooked variety, nutritionally. It is factual that some of the mineral-vitamin containing water in which vegetables are cooked are lost on their removal, but the modern infant has this deficiency made up in many other ways. The greater hazard is that of the careless washing of the vegetables, and the ingestion of pathogenic organisms from the human fertilizers used in the present day cultivation of vegetables, as well as in the preservatives which might still cling to the vegetable or fruit.

### **Foods to Avoid**

Under this heading are some of the common foods found in the average American diet. They are neither toxic nor indigestible to the young child, but they contribute little to his needs, and substitute for the necessary foods upon which his growth and nutrition depend. Furthermore they are interesting to the baby because they are loudly declaimed by the parents as "not good for children," and in his negativism he wants them for the reason that he is audibly denied them.

Pickles, spices and condiments come under this listing, and the baby's palate should need no help in this direction. In addition, these items surfeit the gustatory and olfactory appreciation of plain foods. Sausages and cold cuts find little place in the diet for the above reasons. Beer, wine and other alcoholic beverages obviously offer nothing that the child needs, in addition to the possibility of side reactions. Nuts, popcorn, cherries, grapes and plums (seeds) are foreign body hazards to the respiratory and gastrointestinal tracts, and since they contribute so little, this hazard should be the argument against them. Cantaloupe, watermelon, corn on the cob, radishes, cucumbers, raw cabbage and raw onion are examples of foods which offer multiple objections. Except for the corn, they present nothing in the way of necessary food factors. They are "cocktail" types of foods which are not required as stimulants to the child appetite, and the ex-

cess roughage may irritate the intestinal mucosa. Tea and coffee are not necessary as stimulants, and are often substituted for milk by children.

For the reason that the modern infant and child's diet is so replete in many valuable and easily available food requirements, no important need exists for introducing the exotic or unusual items, when problems of propriety lurk in their inclusion, and many harmful food habits may be begun by their use.

### Suggested Schedule of 1st Year Solid Food Additions

The following outline is presented, merely as a suggestion, and may vary as to the physician's nutritional beliefs and the individual child's requirements. It is to be noted that physical development expressed in terms of pounds, rather than age listings are tabulated, because there should be no diet form listed for a given "age." It still remains an individual matter, open to the discretion of the physician and his interpretation of the infant's actual dietary needs, and its individual tolerances.

1. Fortified cereals—9 to 11 lb. infant.
2. Strained vegetables—10 to 12 lb. infant.
3. Strained fruit—in sequence.
4. Egg yolk (in cereal or milk) and strained meats—12 to 14 lb. infant.
5. Puddings and starchy foods—15 lb. infant.
6. Whole egg, mashed vegetables—16 to 18 lb. infant.
7. Whole *boiled* (3 min.) milk—17 to 18 lb.-on, in place of milk formula.
8. Family food as tolerated with exceptions noted—about 10 months on.
9. Whole milk (*unboiled*) as tolerated—10 to 12 months on.

### MISCELLANEOUS INFORMATION OF FIRST YEAR SOLID FOOD ADDITIVES

**Candy as a Food Problem.** Much confusion exists in the minds of laymen and physicians alike as to whether candy should be offered to the young child. Many children never are permitted to taste candy because of the phobia that some insatiable appetite for this form of carbohydrate will be awakened. It is the author's experience that most modern children, having had the advantage of dietary supervision through infancy, care little for candy, and

treat it casually. This is due no doubt to the fact that there never had been a deficit in the dietary needs, and hence, no inordinate craving for this food will exist. If the same prohibition were placed upon spinach, milk, or meat, as is placed on candy, it is more than likely that the baby would be attracted to it by his negativism. By the same reasoning, taking these foods in excess and sacrificing foods which balance the diet would be equally wrong.

Children can be conditioned early against excessive desires for satiating foods such as candy, by offering the item in question after meals as a regular feature of the daily food intake. When a food is presented without comment, no question arises in the mind of the baby as to its value or place in the menu. Candy should not be offered between meals, as it is completely absorbable, utilized easily, and aborts the desire for other foods. Attention to candy as an especially delectable morsel can be deflected by neither offering it as a reward nor removing it as a penalty, when dealing with minor behavior problems.

The dental profession, more specifically the specialty of pedodontics of dentistry, is most emphatic in its insistence on eliminating sugar and candy from the child's diet. There is irrefutable evidence that the incidence of caries is in ratio to the sugar consumption of the child, which in America in 1948 was assumed to be more than the weight of each child for that year.

Massler states (100) that there is no rational basis for the assumption that calcium and vitamin therapy have any bearing on caries prevention, but that sugar control is the only successful method in the dietary control of dental caries. The acceptance of these facts makes it a still more important problem to the physician and to the parents to solve the candy problem (candy providing for most of the sugar intake), which has been proven responsible for the caries attack rate. The suggestion made in offering the child candy at stated intervals does not conflict with the dental negation. It confirms the need for control of the avid desire for sweets of all kinds. Brushing or flushing the teeth after the ingestion of candy when it is proffered, will neutralize much of the harmful effects of its presence in the mouth where the acidogenic organ-

isms depend on a carbohydrate substrate for acid production—and subsequent caries. Contrary reports exist to Massler's opinion.

**Further Data on Dental Caries.** In a report of the Joint Committee of the American Academy of Pediatrics and the American Society of Dentistry for Children (136) the present status of accepted information on pathology of dental caries, the factors determining caries formation and its prevention are well-presented and reviewed. Since there is no other section of this book which deals with this subject, the summary of the above Committee is quoted here in full and the interested reader of this controversial area is urged to read the entire report.

*Summary of the Joint Committee.* "As dental caries is primarily a disease of childhood and appears to be at least in part preventable, the pediatrician is obliged to be interested in the problem and can play an important part in prophylaxis. Present knowledge indicates that the most effective prevention available is the consumption of fluoridated drinking water containing a concentration of fluoride appropriate to the environmental temperature. Reduction of the intake of refined sugar both in amount and frequency has a beneficial effect on caries control. The prescription of diets essentially devoid of all sugars should be used to stem the progression of rampant caries. That this regimen would be as effective when complex carbohydrates are permitted and only refined sugar prohibited has been indicated by some studies. However, any highly restricted program must be considered therapeutic and not preventive and should be under pediatric supervision."

In a recent survey by the State of Tennessee Health Department (137) it was found that startling reduction of dental caries has been observed since fluoridation of the water supply was begun in 1953. The greatest reduction in decay of permanent teeth was 74% in the six-year-old group. Other ages (*in ital.*) and percentages of reduction were: 7, 61.8%; 8, 58.9%; 9, 42.5%; 10, 35.6%; 11, 21.1%; 12, 15.6%; and at 13 years, 12.8%. If these results can be confirmed by other surveys and by other investigators it will prove the conclusion of the Committee that the consumption of fluoridated drinking water is the most effective prevention of dental caries known at present.

**Bottle "Weaning."** This section is as timely as any to mention briefly the matter of when "*to prohibit*" the infant from taking milk from a bottle, since it deeply concerns many parents. Physicians also are often in a quandary as to how to evaluate this problem.

The infant should be taught to master the motor skill of drinking from a cup as early as possible. After this act has been accomplished, it matters little as to the exact time when the bottle is discontinued. Most of the secure and self-sufficient infants spontaneously stop this procedure in the last months of the first or early months of the second year. Any persistence of this act deep into the second year points toward an infantile reversion for which there must be a cause. The correction is sought in the psychological realm rather than in the disciplinary field. Forceful removal of the bottle without the substitution of some other source of security precipitates more difficulties. In most instances it is best to permit the use of this method of obtaining solace, limited perhaps to one bottle per day, until other corrections are made in the child's environment, or until he becomes more mature and finds security from other sources.

**The Pro and Contra of Printed Diet Blanks.** As has been repeated in this text, infant feeding is an individual matter, and to generalize is to violate this important dictum. Therefore, a prepared, printed formula blank or diet list would not seem to be specific for the needs of each individual. However, a personally written slip of directions and foods creates an air of security and attention in the minds of the parents toward their own child and toward the physician's personal interest. This may be desirable psychologically in specific instances. Printed diet forms, stipulating age groups ("six week diet," "three month diet," "ten month diet") are especially to be deprecated.

There is no objection, however, to having forms printed with many blank spaces which can be made flexible enough for any variation the physician wishes to innovate. Lists of kinds of foods and instructions as to their preparation are rather constant, and it is easy enough to strike out that which does not apply. The busy practitioner wastes valuable time in duplicating orders which might well be spent in verbal advice and explanation to the

mother. Any printed list should be re-edited at intervals as new foods appear, and as the physician's ideas and methods evolve. (In the Appendix will be found a suggested set of forms.)

**“Economics” of First-Year Infant Foods.** For reasons of curiosity, the author attempted to enumerate the intake of foods of all kinds which the *average well* infant is fed during the course of the first year, together with the retail market price in September of 1958. The time of adding various foods would be a factor, as well as the full understanding that every American infant is not fed so ideally. The list was compiled as the author might prescribe these foods in the first year, and this would adhere rather closely to the “schedule” shown on page 183. It is of course a hypothetical summary and is to be taken with this in mind, but it does give an approximate idea of the foods in total, as well as the approximate cost of the items, singly and in total.

If the baby is breast-fed, it is calculated that such an infant would ingest about 48 gallons of human milk if nursed through the sixth month. This would approximate the cost of any formula mixture and would reduce the total cost for the six months to the amount of about \$90.00.

	Total Approx. Cost	Formula Cost only
77½ qts. of evaporated milk (191 13-oz. cans) . . . . .	\$26.74	
21½ pints of corn syrup . . . . . (\$26.74+)	5.20	= (\$31.94)
11¼ 1-lb. or cans of a formula sugar additive \$9.78 (+\$26.74)		= (36.52)
248 13-oz. cans of one of the “one-formula” milks . . (\$71.92)		= (71.92)
28 gals. of whole bottled milk . . . . .	23.32	
10 bxs. of pre-cooked cereal (8-oz. size) . . . . .	2.10	
40 lbs. of strained vegetable or meat-vegetable mixture (135 ¼ oz. jars) . . . . .	13.75	
37½ lbs. of strained fruits (120 4-oz. jars) . . . . .	12.00	
19½ lbs. of strained meats (90 3½ oz. jars) . . . . .	22.50	
14 qts. of egg pudding (80 ¼-oz. jars) . . . . .	8.00	
17½ doz. eggs . . . . .	10.50	
20 ripe bananas or strained in jars . . . . .	2.00	
Juice of 55 doz. oranges . . . . . (\$19.25) or		
44 cans of frozen fruit juice . . . . .	16.80	
or		
330 4-oz. cans of infant fruit juice . . . . . (33.00)		
24 lbs. of potatoes or similar starch foods as rice, macaroni, noodles etc. . . . .	3.00	
18 bxs. chewing foods (zweibach, crackers etc.) . . . . .	4.14	
12 lbs. bacon . . . . .	9.00	
210 cc. of any ADC vitamin concentrate . . . . .	14.65	\$178.70

When the cost of the first-year's diet is multiplied by the 4,277,160 infants, estimated to have been born in 1957 and that survived the first month [average mortality in 1st month 19 to 1,000 live births (127)] it is clear that the baby-food market in this country is a large one—about \$726,117,200 for 1957. Even when one considers that perhaps only half of these infants would receive the ideal diet, the amount would still be upwards of \$340 million.

It is emphasized again that the above estimates are only approximate and for an *average well* baby, and that many infants take more or less than this theoretical infant who weighs 7 lb. at birth. The reader is also reminded again of the vagaries of solid food additives among physicians which would usually raise rather than lower the above figure since the estimates are based on a conservative addition of solid foods and beginning at 3 months. No conclusions are claimed for this presentation. Merely a startling and curious approach to the consumption of food by one small human being in one year.

*Be not the first by whom the new is tried,  
Nor yet the last to lay the old aside.*

ALEXANDER POPE

Chapter Nine

SPECIFIC NUTRIENTS (VITAMINS) AND  
ESSENTIAL ELEMENTS

THE discussion and tabulation in this section will be limited to the material pertaining to recent interest and investigation. The fundamental data on vitamins which have been established and generally accepted will not be discussed except as they are related with newer viewpoints and some controversial features. The tables and textual material will reflect the accepted authorities: *The National Research Council* of the National Academy of Sciences; *The Food and Drug Administration* of the Department of Health Education and Welfare; and the *Canadian Dietary Standard* approved by the Canadian Council on Nutrition. All of these agencies have given permission for the reproduction of the material so credited to them. The author is also indebted to the Mellon Institute of Pittsburgh for the privilege of quoting directly from their excellent epitome—*Nutritional Data* which will be indicated in the tables and text to follow.

TABLE 32  
MINIMUM DAILY REQUIREMENTS OF SPECIFIC NUTRIENTS (174)  
U. S. FOOD AND DRUG ADMINISTRATION, JULY 1957

Specific Nutrient	Units or Mg.	Infants	1 to 5 yrs.	6 to 11 yrs.	12 yrs. and over	Pregnant or Lactating Women
Vitamin A . . . . .	U.S.P. Units	1500	3000	3000	4000	4000
Vitamin B1 (Thiamine) . .	Mg.	0.25	0.75	0.75	1.0	1.0
Vitamin B2 (Riboflavin) . .	U.S.P. Units	83	167	250	333	333
Niacin . . . . .	Mg.	0.6	0.9	0.9	1.2	1.2
Vitamin C . . . . .	Mg.	5.0	5.0	7.5	10.0	10.0
Vitamin D . . . . .	Mg.	10.0	20.0	20.0	30.0	30
Calcium . . . . .	U.S.P. Units	200	400	400	800	800
Phosphorus . . . . .	U.S.P. Units	400	400	400	400	400
Iron . . . . .	Mg.	750	750	750	750	1.5 (grams)
Iodine . . . . .	Mg.	750	750	750	750	1.5 (grams)
	Mg.	7.5	7.5	10	10	15.0
	Mg.	0.1	0.1	0.1	0.1	0.1

(The above values are given by the Administrator of the Food and Drug Administration as minimum daily requirements at levels, which amounts less than those given, would produce demonstrable deficiency signs, but are not considered amounts which would be therapeutic.)

TABLE 31  
FOOD AND NUTRITION BOARD, NATIONAL RESEARCH COUNCIL RECOMMENDED  
DAILY DIETARY ALLOWANCES, REVISED 1958 (131)  
(Publication 589)

Designed for the maintenance of good nutrition of healthy persons in the U.S.A.  
(Allowances are intended for persons normally active in a temperate climate)

	Age Years	Weight kg. (lb.)	Height cm. (in.)	Calories	Protein gm.	Cal- cium gm.	Iron mg.	Vitamin A I.U.	Thiam. mg.	Ribo- mg.	Niacin* mg. equiv.	Asc. Acid mg.	Vitamin D I.U.
Men	25	70 (154)	175 (69)	3200	70	0.8	10	5000	1.6	1.8	21	75	
	45	70 (154)	175 (69)	3000	70	0.8	10	5000	1.5	1.8	20	75	
	65	70 (154)	175 (69)	2550	70	0.8	10	5000	1.3	1.8	18	75	
Women	25	58 (128)	163 (64)	2300	58	0.8	12	5000	1.2	1.5	17	70	
	45	58 (128)	163 (64)	2200	58	0.8	12	5000	1.1	1.5	17	70	
	65	58 (128)	163 (64)	1800	58	0.8	12	5000	1.0	1.5	17	70	
	Pregnant (second half) Lactating (850 ml. daily)			+300 +1000	+20 +40	1.5 2.0	15 15	6000 8000	1.3 1.7	2.0 2.5	+3 +2	100 150	400 400
Infants	0-1-12 2/12-6, 12-6 (13) 7/12-12/12-9 (20)		60 (24) 70 (28)	kg. X 120 kg. X 100	See Text	0.6 0.8	5 7	1500 1500	0.4 0.5	0.5 0.8	6 7	30 30	400 400
Children	1-3	12 (27)	87 (34)	1300	40	1.0	7	2000	0.7	1.0	8	35	400
	4-6	18 (40)	109 (43)	1700	50	1.0	8	2500	0.9	1.3	11	50	400
	7-9	27 (60)	129 (51)	2100	60	1.0	10	3500	1.1	1.5	14	60	400
	10-12	36 (79)	144 (57)	2500	70	1.2	12	4500	1.3	1.8	17	75	400
Boys	13-15	49 (108)	163 (64)	3100	85	1.4	15	5000	1.6	2.1	21	90	400
	16-19	63 (139)	175 (69)	3600	100	1.4	15	5000	1.8	2.5	25	100	400
Girls	13-15	49 (108)	160 (63)	2600	80	1.3	15	5000	1.3	2.0	17	80	400
	16-19	54 (120)	162 (64)	2400	75	1.3	15	5000	1.2	1.9	16	80	400

\* Niacin equivalents include dietary sources of the preformed vitamin and the precursor, tryptophan. 60 milligrams tryptophan equals 1 milligram niacin.

TABLE 33  
ABRIDGED CANADIAN DIETARY STANDARDS  
(Table and textual material taken from NUTRITIONAL DATA (121, 24))

	Weight lbs.	Age	Calories	Protein g.	Calcium g. and Phos. Values	Iron mg.	Vitamin A I.U.	Thiamine mg.	Riboflavin mg.	Niacin mg.	Ascorbic Acid mg.	Vitamin D I.U.
Children Boys or Girls	20	1	1050	35	1.0	6	700	.30	.50	3.0	30	400-800
	30	3	1300	37	1.0	6	1000	.40	.65	4.0	30	400
	40	5	1600	40	1.0	6	1300	.50	.80	5.0	30	400
	50	7	1800	45	1.0	6	1600	.55	.90	5.5	30	400
	60	9	2100	50	1.0	6	2000	.65	1.10	6.5	30	400
	70	10	2300	55	1.0	6	2300	.70	1.15	7.0	30	400
Girls	80	11	2450	60	1.0	6	2600	.75	1.25	7.5	30	400
	90	12	2475	65	1.5	6	3000	.75	1.25	7.5	30	400
	100	14	2500	70	1.5	12	3300	.75	1.25	7.5	30	400
Boys	80	12	2500	60	1.0	6	2600	.75	1.25	7.5	30	400
	90	13	2650	65	1.5	12	3000	.80	1.30	8.0	30	400
	100	14	2850	70	1.5	12	3300	.85	1.40	8.5	30	400
	100	15	3000	80	1.5	12	3600	.90	1.50	9.0	30	400
Women	100	—	1825	50	.45	12	3200	.55	.90	5.5	30	—
	100	—	2600	50	.45	12	3200	.80	1.30	8.0	30	—
	140	—	2325	60	.65	12	4600	.70	1.10	7.0	30	—
			3100	60	.65	12	4600	.95	1.50	9.5	30	—
	In pregnancy latter half, <i>add</i> Lactation, <i>add</i>		up to 500	25	1.0	3	2000	.15	.20	1.5	—	400
			up to 1000	25	1.0	3	2000	.30	.50	3.0	—	400
	140	—	2325	60	.65	6	4600	.70	1.10	7.0	30	—
	140	—	3600	60	.65	6	4600	1.10	1.70	11.0	30	—
	180	—	2725	75	.80	6	5900	.80	1.30	8.0	30	—
	180	—	5000	75	.80	6	5900	1.50	2.40	15.00	30	—
Men	140	—	2325	60	.65	6	4600	.70	1.10	7.0	30	—
	140	—	3600	60	.65	6	4600	1.10	1.70	11.0	30	—
	180	—	2725	75	.80	6	5900	.80	1.30	8.0	30	—
	180	—	5000	75	.80	6	5900	1.50	2.40	15.00	30	—

(From the Canadian Dietary Standard and approved by Canadian Council on Nutrition—1953).

The Canadian Standard, in addition to those nutrients given in Table 33 (page 191), discusses the following important food factors:

**Common Salt**—An average diet using unsalted foods exclusively contains about 3 grams of sodium chloride daily. With no restriction of salt, average diets provide 7 to 15 grams of sodium chloride daily. A daily intake of 5 grams of sodium chloride is adequate for most persons, though several times this amount can be eliminated without harm by the normal individual. Under conditions where sweating is heavy, additional salt intake up to 30 grams per day for an adult may be desirable.

**Iodine**—The requirement for iodine is probably not over .004 milligram per day per kilogram of body weight, or from 0.15 to 0.30 milligram per person. This amount is supplied by ordinary iodized table salt.

**Copper**—Any normal diet supplying adequate iron and phosphorus will also supply the quantity of copper needed.

TABLE 34  
APPROXIMATE PERCENTAGES OF ESSENTIAL ELEMENTS OF VARIOUS MILKS

Milks	Human	Cows	Goats
Calcium.....	0.034	0.122	0.128
Magnesium.....	0.005	0.013	0.017
Potassium.....	0.048	0.154	0.17
Sodium.....	0.011	0.06	0.08
Phosphorus.....	0.015	0.09	0.112
Sulfur.....	0.0035	0.116	0.12
Chloride.....	0.036	0.116	0.15
Iron.....	0.0001	0.00004	0.00002
Copper.....	0.00003	0.00002	0.00002

*Data on Human and Cows' Milk—Infant Nutrition:* P. C. Jeans and W. M. Marriot, C. V. Mosby Company, St. Louis, Missouri, 1947. (89)

*Data on Goats' Milk*—in part from Dr. E. L. Foreman, Special Milk Products Company, personal communication; in part from *Department of Agriculture Technical Bulletin #671*. (62)

OTHER ESSENTIAL ELEMENTS AND SPECIFIC NUTRIENTS

The requirements for some nutrients and elements both tabulated and otherwise are often variable and are here appended by discussion. The following textual material is taken from NUTRITIONAL DATA (121) extracted from the National Research

Council Recommended Dietary Allowances and from the NRC Publication 589 (131) directly, in total or in part.

**Sodium, Potassium, and Chlorine (131).** These three elements are indispensable dietary constituents and function prominently in the maintenance of water balance. Potassium is especially abundant in both plant and animal tissues and does not need consideration as a dietary adjunct.

The average intake of sodium chloride (salt) for the normal adult is 7 to 15 grams daily. This includes sodium and chlorides contained in foods as well as those added to food as salt. It more than meets the normal requirements.

**Phosphorus (131).** In the original table no allowances were formulated for phosphorus because of the view that dietary deficiencies of phosphorus are uncommon and that diets which are adequate in other respects, particularly in calcium, are ordinarily adequate in phosphorus. In preparation for the 1945 revision, a large amount of published and unpublished data from balance studies was brought together and evaluated. The evidence indicates that the phosphorus allowances should be at least equal to those for calcium in the diets of children and women during the latter part of pregnancy and during lactation. For other adults the phosphorus allowances should be approximately one and one-half times those for calcium. In general, it is safe to assume that if the calcium and protein needs are met through common foods, the phosphorus requirement also will be covered, because the common foods richest in calcium and protein are also the best sources of phosphorus.

**Copper (131).** The requirement for copper for adults is about 1 to 2 milligrams daily. Infants and children require approximately 0.05 milligrams for each kilogram of body weight. The requirement for copper is approximately one-tenth that for iron. A good diet normally will supply sufficient copper.

**Iodine (131).** The requirement for iodine is small, probably about 0.002 to 0.004 milligrams daily for each kilogram of body weight, or a total of 0.15 to 0.30 milligrams daily for the adult. This need is met by the regular use of iodized salt; its use is especially important in *adolescence* and *pregnancy*.

**Fluorine (131).** Small amounts of fluoride are generally present in plant and animal tissues, especially in bones and teeth. No conclusive evidence that fluorides have an essential function in nutrition or metabolism has been adduced. However, extensive evidence indicates that during tooth development a controlled intake of fluoride, such as is provided by drinking water containing about 1 part per million, results in substantial protection against dental caries. This practice is recognized as an important public health measure.

**Calcium (131).** Calcium participates in multiple physiological functions in addition to being a major component of the skeleton and teeth. Since the 1953 revision, further evidence has accumulated that adaptation to wide ranges of calcium intake is possible without manifestation of observable effects and without contributing to the determination of desirable intakes.

An allowance of 800 milligrams of calcium per day for adults (excluding pregnancy and lactation) was recommended in 1953 after intensive analysis of the data of balance studies and of surveys of customary dietary intakes of various population groups. Ingestion of excessive calcium in foods has not been shown or seriously considered to be harmful. The recommended allowance of 800 milligrams of calcium for adults is therefore reaffirmed.

The allowances for pregnancy and lactation are intended to provide for the growth of the fetus during the last trimester and for milk production (50, 54). It should be emphasized that the limitation of increases in the dietary to the last trimester of pregnancy assumes a well-nourished woman at the onset of pregnancy. Where there has been previous undernutrition, increased intake of calcium should be supplied earlier.

Beal has reported on the calcium intake of 57 children from birth to age 7 years, studied during the period 1946 to 1955 by the Child Research Council in Denver. Growth patterns of the children were considered satisfactory by the standards of the Child Research Council. The median daily intake of calcium increased from 0.6 gram during the first month of life to 1.0 gram by the sixth month, and remained at this level until age 1 year. The median then fell steadily to 0.75 gram between 2 and 3 years, to rise again to 1.0 gram level by age 5. The curve of intake is reported as following the conformation of the theo-

retical curve derived by Sterns for calcium requirements for skeletal growth; this provides added support for the use of previously accepted concepts as guides to the recommendations for calcium intake of children and adolescents. (See also page 207 as to inadequate calcium in premature infants.)

**Iron (131).** The chief functions of iron are as a component of hemoglobin and of oxidative enzyme systems.

The recommended allowances for iron were originally based to large extent on the suggestion of Sherman that 12 milligrams is a desirable level of intake for adults. The mean intake of 8 milligrams required by his subjects for equilibrium was increased by 50 per cent to provide for individual variations. There is considerable evidence that adult males can maintain normal hemoglobin concentration with very low intakes of iron.

The iron requirements of infants relate largely to the needs for rapid growth. The studies of Smith *et al.*, using radioactive iron have suggested that utilization of dietary iron apparently does not occur during the first 4 to 5 months of life. Balance studies show equilibrium on an intake of 0.15 milligram per kilogram per day, approximating the intake of iron in an all-milk diet. Requirements for the first year of life have been estimated on the basis of the growth of the myoglobin and hemoglobin compartments, indicating a total need of 145 to 192 milligrams. Using the higher value, a retention of approximately 0.8 milligram per day for the last 8 months of the year may be calculated. Since the absorption of food iron in this age group approximates 10 per cent of the intake, an intake of about 8 milligrams per day or 0.8 milligram per kilogram per day is amply supported. The recommended allowances for iron during the first year of life have therefore been based on an intake of 0.8 milligram per kilogram per day.

During the second year of life the growth rate diminishes and requirements for iron are likewise reduced. Balance studies made on children age 3 to 6 years suggest that intakes of at least 0.3 to 0.4 milligram per kilogram per day are necessary. The allowances for the pre-school years were obtained by using these values in relation to body weight at different ages.

For children of school age, the allowances are supported by the studies of Johnston and Roberts, who found that intakes of 0.35 milligram per kilogram per day were adequate to maintain

normal hemoglobin levels as judged by lack of response to further iron supplementation. Iron requirements during adolescence are enhanced because of the growth spurt which occurs at this age. Allowances of 15 milligrams have therefore been proposed for age groups from 13 to 15 years.

The demands of pregnancy have been estimated to require an increase of about 3 milligrams per day over normal requirements. The data of Hahn and associates indicate that this increment is more important during the later half of pregnancy. No data are available concerning the iron requirements during lactation. Since iron secreted in the milk may amount to 1 milligram per day, an additional intake equal to that in pregnancy is suggested.

\* \* \* \* \*

**Additional Observations on Iron Deficiency.** Recent studies have been made to determine how iron deficiency is reflected in the newborn infant (160). There were 66 mothers in this series studied during pregnancy and their respective infants were observed in the first 3 to 5 days of life. The infants were divided into non-anemic, moderately anemic and severely anemic groups reflecting their mothers' status during the last six weeks of pregnancy. The most notable index of mothers' iron deficiency was observed in red cell volume and circulating hemoglobin mass. Infants of mothers on oral iron therapy during pregnancy had higher total circulating serum iron levels than in infants of untreated mothers. It was unusual for non-anemic mothers to give birth to infants with iron deficiency, and anemic infants shared their mothers' deficiency. The more severe the anemia of the mother the more likely it was reflected in the baby at birth. It was projected by the authors that such a profound effect on the neonate would be expected to influence the appearance of iron deficiency anemia later in infancy.

Jackson summarizes much of the accepted dicta on iron deficiency in infants in an authoritative editorial (87):

"Four to six months after birth, the hemoglobin value reflects the dietary regimen and the incidence of infection. Hypochromic anemia occurs most commonly in infants receiving excessive amounts of milk and insufficient amounts of solid foods. An in-

infant receiving only the slight amount of iron found in milk generally has a slow decrease in hemoglobin level during the latter half of the first year. If his original iron store is poor, an iron-deficiency anemia will appear in late infancy. It is wise to begin the addition of iron-containing foods at the time when the infant reaches his minimum hemoglobin level (10.5 to 11.5 gm. per 100 ml.), and that time is about three months after birth. The requirement of iron is about 5 mg. daily. The common iron-containing foods fed to young infants, egg yolk and green vegetables, provide 1 to 2 mg. daily at most. The sieved meats provide 0.5 to 1.7 mg. to the ounce. Many of the special infant cereals have iron added in amounts providing 2.5 to 4 mg. to the serving of  $\frac{1}{3}$  oz. (10 gm.). The infant born at term of a healthy well-fed mother will maintain a good hemoglobin level for at least six months if it is free from infection. If he receives some iron-containing foods daily after the fourth month, probably no other iron supplements are necessary. Schulman, Smith, and Stern (151) found that iron given to prematurely born infants before the third or fourth month after birth produces little clinical response. Iron after the third or fourth month not only is essential but is well utilized and will prevent the development of hypochromic anemia."

### Resurgence of Hospital-Observed Nutritional Anemia

It would be *apropos* at this point to retract a statement made in the former text as not being factual any longer. It was stated there that in recent years at the Children's Memorial Hospital, Chicago, there had been seen few, if any, patients in the first year with a secondary nutritional anemia. The suggestion was made that perhaps the addition of supplemental foods in the first year such as fortified cereals, vegetables, fruits and egg yolk prevented the formerly commonplace *anemia of the second half of the first year* from appearing, and that perhaps it was an entity, like rickets and scurvy, which was well-nigh extinct. Within a year after the publication of that statement Dr. John Bigler, Chief of Staff of the hospital, called the author's attention to the fact that there had been 18 or more of these patients with secondary anemia from faulty nutrition admitted to the hospital for treatment. Since then there have been as many or more constantly appearing in the clinic patients. It was Dr. Bigler's opinion that

perhaps the literal acceptance of *demand feeding*, by parents without the intellectual background to understand its full implication, accounted for the rather sudden increase of this defective nutritional entity. Most of the patients had the history of not accepting solid food, such as vegetables and fruit, and subsisted almost entirely upon milk because "children should not be forced to eat if they don't want to." And thus, the literal interpretation of the gentler approach to child culture may have its reverberations in the deficiency nutrition of children, when its original tenets were not meant to imply this perversion of understanding of an accepted modern principle of child care.

\* \* \* \* \*

**Vitamin B<sub>6</sub>.** Vitamin B<sub>6</sub> is a complex of three closely related chemical compounds: pyridoxine, pyridoxal, and pyridoxamine. Pyridoxal phosphate has been shown to be the active co-enzyme form of this complex. Vitamin B<sub>6</sub> occurs in animal products largely as pyridoxal and pyridoxamine, in plant products as pyridoxine.

The need for and function of vitamin B<sub>6</sub> in human nutrition has been demonstrated only recently, though there are several earlier indications of its essentiality. Rough estimates of human vitamin B<sub>6</sub> requirements may be made from certain animal experiments and tests with humans. Balance studies are questionable for this purpose, since no evidence is available on the effect of intestinal synthesis (121).

"Inasmuch as vitamin B<sub>6</sub> is involved in such fundamental biochemical reactions, it is fortunate that it occurs in many different foods. Except in very unusual circumstances, signs of vitamin B<sub>6</sub> deficiency have not been recognized in human beings. However, convulsions have occurred in infants fed on autoclaved liquid milk preparation which proved to be deficient in vitamin B<sub>6</sub>, and anemia and convulsions have been reported in other infants fed a synthetic formula devoid of vitamin B<sub>6</sub>. Adult persons who received a vitamin B<sub>6</sub> antagonist, 4-deoxy-pyridoxine, developed seborrheic dermatitis, mucous membrane lesions, and peripheral neuritis. The antituberculosis drug, isoniazid, acts as a vitamin B<sub>6</sub> antagonist and may cause peripheral neuritis unless additional vitamin B<sub>6</sub> is given. Pregnant women with apparently normal vitamin B<sub>6</sub> stores have alterations of

tryptophan metabolism which can be eliminated by added vitamin B<sub>6</sub>. Recently, several patients have been observed who had an unusual variety of hypochromic anemia which responded to the administration of vitamin B<sub>6</sub> even though their diets contained the usual quantity of this vitamin.

"The evidence available from animal experiments and tests on human volunteers indicates that the daily intake of vitamin B<sub>6</sub> should be from 1 to 2 milligrams, an amount which is readily provided by ordinary mixed diets" (131).

**Vitamin B<sub>12</sub> (Cyanocobalamin) (121).** Vitamin B<sub>12</sub> has been found to be an essential nutrient in many animal species and its metabolic functions have been the subject of wide investigation. In man, observations on the hemopoietic activity of vitamin B<sub>12</sub> support the suggestion that approximately 1 microgram daily parentally will allow replacement of the lack in pernicious anemia. Present information is not sufficient to permit extrapolation of this estimate to the dietary requirement of healthy adults.

The provision of supplementary vitamin B<sub>12</sub> to premature infants has not resulted in growth stimulation. It appears probable that normal infants being fed on cows' milk formulas or on human milk receive sufficient vitamin B<sub>12</sub> to meet their needs.

Some workers have reported data interpreted as indicating a growth stimulation in children. Data from other studies fail to provide evidence of effectiveness of vitamin B<sub>12</sub>. These investigations are of varying quality, but each is subject to one or more of the following limitations; smallness of samples, failure to match age and sex grouping in control and supplemented groups, failure to eliminate psychologic factors, inadequate information concerning dietaries of the individuals studied, and absence of information on the vitamin B<sub>12</sub> content of the foods consumed. The data available are insufficient as a basis for a recommended dietary allowance of vitamin B<sub>12</sub>.

**Vitamin K (131).** Numerous compounds with vitamin K activity have been described. All are derived from or are related in structure to 2-methyl-1, 4-naphthaquinone. Occurring in nature are vitamin K<sub>1</sub>, which is present in green leaves, and vitamin K<sub>2</sub> which is found in microorganisms. The vitamin is required for maintenance of normal prothrombin levels in the blood, an ac-

tivity which relates to an effect on true prothrombin and factor VII. Recent observations indicate also that vitamin K may be active in stimulating oxidative phosphorylation in tissues.

Under usual circumstances the average diet plus synthesis by intestinal bacteria provide adequate amounts of vitamin K. The newborn infant has decreased serum levels of several coagulation factors in the prothrombin complex. These factors decrease further during the first week of life but spontaneously return toward normal adult concentrations in subsequent weeks. On the basis of laboratory evidence, the routine maternal or neonatal administration of vitamin K has been advocated for the prevention of hemorrhage in the newborn. This practice is now questioned on several grounds:

TABLE 35  
VITAMIN B<sub>12</sub> AND FOLIC ACID VALUES IN MILKS (36) (106)

	Vitamin B <sub>12</sub> (values in micrograms per liter)	Folic Acid
Human Milk.....	0.41	0.71
Cows' Milk (pasteurized).....	4.0	2.6
Goats' Milk.....	0.12	2.7

The minimum daily requirements or the recommended daily allowances for normal infants and children of vitamin B<sub>12</sub> and folic acid have not been established. Dr. W. W. Zuelzer (193), a member of the committee of investigators states that "It was the feeling of the Boston meeting that if Nature had set the amounts of folic acid and vitamin B<sub>12</sub> as low as has been recorded, that that probably was ample to fulfill the needs of the infant." Spies (163) gives the minimum effective parenteral dose of vitamin B<sub>12</sub> in adult human beings as about 1.0 mg. daily. This is a treatment dose and may be well in excess of the daily requirement. As has been stated elsewhere from the evidence at hand, there is no urgent need to supplement, with vitamin B<sub>12</sub> or folic acid, the diet of normal infants being fed cows' milk. (See page 204 for further discussion of vitamin B<sub>12</sub>).

1. It has been difficult to prove that these decreased levels of coagulation factors are a direct cause of neonatal hemorrhage.

2. There is conflicting evidence that the routine administration of vitamin K in larger series of pregnancies has affected the incidence of neonatal hemorrhage.

3. There is a continuing dispute among workers in coagulation as to the validity and significance of alterations in coagulation phenomena of the newborn following vitamin K administration.

4. Hemolytic anemia in the rat and kernicterus in the baby may result from excessive dosage of water-soluble preparation of synthetic vitamin K.

In the absence of liver disease, there seems to be no reason to supplement maternal diets in this country with vitamin K. It may be administered to mothers in labor or to their newborn infants in situations conducive to neonatal hemorrhage (e.g., prematurity, anoxia, erythroblastosis) as synthetic water-soluble K in dosages of 2 to 5 milligrams for the mother or 1 to 2 milligrams for the baby.

### VITAMINS PERTAINING TO HUMAN MILK

The milk of a healthy human mother whose diet is nutritionally adequate contains sufficient amounts of specific nutrient factors except for vitamin D, iron, and possibly thiamine, as stated by Jeans and Marriott (89). They further add that Nature presumably intended that vitamin D would be obtained from the sun.

It is obvious that on the basis of 24 oz. (720 gm.) of human milk per day an infant will receive more than the 30 mg. of ascorbic acid recommended by the NRC. It is also seen that the vitamin D content in this quantity of human milk is insufficient and that vitamin D should be supplemented to the diet of any breast-fed baby. There is no necessity for the addition of any of the more expensive fractions of vitamin B to the breast-fed infant's dietary except for the obvious deficiency in the diets of the lower-income-group mothers who are nursing their infants.

### VITAMINS PERTAINING TO COWS' MILK

In Table 36 are presented the vitamin values for pasteurized unfortified whole cows' milk. As stated elsewhere and repeated here for emphasis, most commercially-sold, bottled cows' milk (400 units per qt.) and all evaporated milks (400 units per 13 oz. can) have been fortified with vitamin D which would be sufficient to cover the infant's needs. It remains none-the-less, the clinical custom to add vitamin D to the dietary intake of all breast-fed or bottle-fed infants despite this apparent presence of vitamin D in any fortified milk.

**Is There a Vitamin B Deficiency in Infants?** It is generally conceded that a primary deficiency of vitamin B and its complex is clinically not recognizable in infants. No doubt subclinical states are found after debilitating conditions, but the diagnosis of a vita-

min B deficiency is not easily demonstrated. The Commission on Nutrition from the University of Chicago despatched to Puerto Rico some years ago, found many nutritional deficiencies, but were not able to demonstrate a B defect in any of the babies of that crowded island. The investigators sent to examine the children of France following the German occupation were not able to demonstrate any deficiency of vitamin B in the infants, where most every other deficiency condition was found. Little proof exists for the claims of manufacturers of the need for the vitamin B fractions in babies, and the opinion is widely accepted by in-

TABLE 36  
VITAMIN CONTENT OF HUMAN, COWS', AND GOATS' MILKS  
(Vitamin content per 100 gm. or cc.)

Type of Milk	A	B <sub>1</sub> Thiamine	B <sub>2</sub> Riboflavin	Niacin	C	D
Human . . . . .	290 I.U.	.014 mg.	.037 mg.	0.13 mg.	5.0 mg.	5.0 I.U.
Cow . . . . .	170 I.U.	.045 mg.	.210 mg.	0.10 mg.	2.0 mg.	2.5 I.U.
Goat . . . . .	170 I.U.	.060 mg.	.080 mg.	data lacking	1.5 mg.	1.3 I.U. (varies seasonally)

Data on Human and Cows' Milk—I. C. Maey, *et al.* (99)  
Data on Goats' Milk—same sources as Table 34.

vestigators and physicians that the need for many of the products now on the market in profusion is not justified. Further research as to a B deficiency syndrome may bring to light facts which are masked by other clinical states known at the present, but at this time, true vitamin B deficiency in the infant is a questionable diagnosis to concede. It certainly is not as common as the multiplicity of products containing these fractions would indicate.

The only fraction of the vitamin B complex in which infants are apparently deficient when on a diet of human milk or dilution of cows' milk is that of B<sub>1</sub> or *thiamine* (92). The minimum thiamine requirement for infants is 0.25 mg. (see Table 32), while the allowance of the National Research Council is 0.4 mg. daily (see Table 31).

Both human milk and cows' milk dilutions contain slightly less than the minimum requirements. Infants on both milks seem to do well enough nutritionally, despite this minimum intake, without

developing any clinical evidence of thiamine deficiency. This apparent (mathematical) lack is soon made up by the addition of fortified cereals early in the first year and later by the enriched bread and flour now generally available.

Thiamine is said to have a stimulating effect on the appetite—hence, the generous prescribing of B complex preparations to children who offer the symptom of poor appetite so widely complained of in the private pediatric practice. It is a sad commentary on the integrity and intellectual honesty of the physician who reaches for a prescription blank when presented by this ubiquitous difficulty—*anorexia nervosa*—instead of taking the time to instruct the parents of the origin, and psychological correction of bad feeding habits. The correction of these habits and most of the behavior problems related to food taking have little relation to thiamine, vitamin B, or any other type of medication. And yet, many dollars are paid out by the parents at the advice of the physician to purchase the most expensive of all of the vitamin products—vainly trying to correct this psychological state of early infancy and childhood. (See last section of this chapter.)

**Recent Appraisal of Commercial Interest in Vitamin B<sub>12</sub>.** Another fraction of the vitamin B complex which deserves further observation is that of B<sub>12</sub> which has been seized upon commercially and exploited with insufficient scientific evidence to support the promotion it has received. It would be well to rely on authoritative sources for an opinion on this controversial matter. (Also see Table 35 and appended footnote.)

The Council on Foods and Nutrition of the A. M. A. authorized publication of a report by six active investigators of infant nutrition in a conference held at the Massachusetts General Hospital (36). Excerpts from this report are quoted:

“The group attending this conference did not believe there was evidence of widespread deficiency of vitamin B<sub>12</sub> and folic acid among infants and children as revealed by megaloblastic anemia or suboptimal growth. A cautious attitude was assumed toward employment of vitamin B<sub>12</sub> or folic acid in an attempt to augment the normal growth of healthy infants being fed either artificially or by a well-nourished mother. *Any studies claiming improved*

*growth in normal children from supplementary vitamin B<sub>12</sub> or folic acid will have to be appraised critically. . . .* There would not seem to be any urgent need to supplement, with vitamin B<sub>12</sub> or folic acid, the diet of normal infants being fed cows' milk. . . . The group did not feel that evidence presented justified widespread prophylactic use of vitamin B<sub>12</sub> or folic acid in order to meet the extra requirements of the occasional pathologic situations." (See Zuelzer, page 200.)

The Committee on Nutrition of the American Academy of Pediatrics has seen fit to clarify the controversial area which surrounds the commercial application and exploitation of our knowledge of vitamins B<sub>1</sub> and B<sub>12</sub> as it pertains to stimulating growth and increasing the appetite and nutrition of children. This could not be stated more succinctly than is done in this report which is here presented in part as it appears in the original (34). The interested reader who is confused with the controversial opinions in this field is urged to become oriented by reading the entire report of the Committee which does much to clarify and stabilize the conflicting data which have appeared on this subject. The recommendations and opinion of this Committee follows:

The problem of "poor appetite" in normal children has been a frequent concern to lay individuals. It is inevitable that an emotional reaction may be engendered in parents and that physicians often are requested to recommend a "tonic" or supplement for their patients. The alert physician should be justifiably concerned about the usefulness of appetite stimulators and growth-promoting substances. It seems necessary to re-evaluate the presently available literature which deals with vitamins B<sub>1</sub> and B<sub>12</sub> and to objectively assess those data upon which a variety of claims have been made that these substances increase growth and stimulate appetite.

It is important to again emphasize that phases of irregular growth are normal and that a period of "growth spurt" is an expected occurrence in normal adolescence. It is therefore, necessary to place the term appetite in correct focus when dealing with growth in different age groups.

A multiplicity of factors control this subjective interest in food, and some of these have a greater or lesser part to play in

the particular problem of the individual child. Food habits, particular likes and dislikes and cultural influence are all important in assessing the subjective interest in eating. The emotional make-up of a particular child, personality factors, intrafamilial tensions and other psychogenic factors certainly contribute to the problems of appetite and food intake. The unattractive preparation of food, intercurrent infection and chronic disease may all contribute to decreased food intake. The interaction of these factors may confound the situation and make difficult any assessment of the need for a single or several nutrients by any group of children.

### *Conclusions on Vitamins B<sub>1</sub> and B<sub>12</sub>*

The great mass of information on the beneficial influence of thiamine in markedly deficient animals is probably not applicable to any but the most severely deprived humans. No secure data are at hand that thiamine administration to humans "stimulates" appetite; this does not conflict with the well-recognized fact that the vitamin is essential for body processes.

The evidence for appetite-stimulating or growth-promoting effects of vitamin B<sub>12</sub> is not convincing. Whatever the specific medical or nutritional indications for vitamin B<sub>12</sub> may prove to be, in children, it is clear that this vitamin does not encourage appetite so as to cause increased growth in children. Admitting that the design of experimental work with humans is fraught with difficulties, the lack of scientifically acceptable control subjects makes much of the evidence advanced in support of specific effects of vitamin B<sub>12</sub> unacceptable.

The impression should not be conveyed to the physician that "growth failure" is commonplace and that all flagging appetites are due to inadequate intake of either or both of these vitamins. On the basis of current knowledge, claims for any effect of these vitamins in either stimulating appetite or promoting growth are not justified. Present evidence is insufficient to show any effect of vitamin B<sub>1</sub> and vitamin B<sub>12</sub> on stimulation of appetite or growth except in deficiency states.

This discussion in no way detracts from the metabolic significance or usefulness of these two important vitamins. It is clear that, at present, we do not yet fully understand appetite or all the factors which affect growth. Humility should govern the at-

titudes of manufacturers and physicians alike when it is urged that growth-promoting substances be given to large groups of children.

**Is Vitamin A a Necessary Supplement in Infancy?** No proven need exists for vitamin A in special preparations to be given to infants in addition to that found in the normal diet. The only exceptions to this are for special therapeutic purposes, as in conditions of impaired fat absorption (cystic fibrosis, celiac syndrome), and in prematurely born infants who have been shown to have poor fat absorption (28). Vitamin A is abundant in many of the foods offered to infants, and any reasonably good diet contains ample amounts to meet the minimum requirement, as well as for storage. If a diet is deficient in vitamin A, it is also lacking in many other essentials, and much more is needed than the special addition of vitamin A alone. This is concurred in by many observers, and is re-emphasized by Jeans (90).

Because vitamin A is fat-soluble and is obtained from the same sources as vitamin D, it usually appears in the same menstruum although additional amounts would not need to be supplemented. Since in the commercial product the effort would be more expensive and more difficult to remove it from the vitamin D component of the combined preparation, both vitamins A and D are prescribed together with impunity. Only when over-enthusiastic dosage by uninformed lay attendants would make this combination dangerous (see page 208), no other drawback is recognized.

#### **SUPERFLUOUS OVERDOSAGE OF VITAMIN D**

In the enthusiasm for prescribing vitamin needs for babies, the error is often made of exceeding the requirement. Stearns, Jeans and Vandercar proved that an excessive dose of vitamin D retards growth rather than promotes it (165). Infants given 1800 to 2000 units of vitamin D daily grew rapidly at first and then lagged even behind the group who were receiving 135 units, and far behind those receiving 300 to 400 units.

It has been widely accepted that the premature infant requires more vitamin D than the full-term baby. This has been shown to be erroneous. Glaser, Parmalee, and Hoffman presented concrete

evidence in a very excellent study (66) of 166 premature infants at the Cook County Hospital, Chicago, over an eight-month period of observation. They observed that a dose of only 100 units of vitamin D daily of any preparation was sufficient to prevent clinical signs or symptoms of rickets, in spite of their prematurity, and that 85% of them were Negro, both factors of which are known to favor the production of the disease. They suggest that 400 to 800 units allow a greater margin of safety in case of illness or temporary neglect.

This concept that the premature infant requires more vitamin D than the full-term infant is probably based on the premise that the premature baby is known to develop rickets more often, but the difficulty lies in the calcium and phosphorus deficiency rather than in an increased need for vitamin D (16). The premature baby is handicapped at birth by the fact that the mineralization of the bones occurs in the last months of fetal life—an infant born only one month prematurely has only half the amount of calcium deposited in the skeleton than if carried to full term (27, 65). It also has a smaller capacity for food, despite greater increments of expected growth. Rickets has been found in infants who received large amounts of vitamin D (41). Human milk supplies enough calcium and phosphorus for the needs of the full-term infant, but this is not sufficient for optimum growth of the infant born earlier than term. If human milk is fed to premature infants, some other source of minerals must be added to supply the need, and large doses of vitamin D will not make up for this deficit (91). (See page 225). When the calcium and phosphorus requirement is supplied, the need for vitamin D in the prematurely-born baby is the same as the newborn at term as shown by Glaser, *et al.* (*loc. cit.*).

#### VITAMIN AND IRON "POISONING"

It would seem difficult indeed to imagine that the innocuous specific nutrients could be given in large enough dosage to produce toxic effects in the human body, and yet such situations have arisen. This has been brought about by the availability of aqueous preparations of vitamins A and D since it has been demonstrated that greater absorption occurs when an aqueous dispersion replaces a preparation in an oily base (95, 125).

*Hypervitaminosis D* has been reported many times (15, 38) but the maximum toxic dose varies in infants and it is cumulative as well, since it is stored in the body. The effects are permanent kidney damage, deposition of calcium in terminal arterioles in any organ of the body, and dense deposition of mineral in the zone of provisional calcification in the metaphyses of the long bones, at the expense of the diaphyses.

*Vitamin A intoxication* from overdosage results in a syndrome described by Caffey (22) and has been reported over 25 times since 1944. Overdosage was due to over-enthusiasm for vitamin taking or "giving," and ignorance of the dangers of high vitamin intake in all of the cases reported in the literature. Caffey states that the hazards of vitamin A poisoning from the routine prophylactic ingestion of vitamin concentrates A and D to healthy infants and children on good diets are considerably greater than the dangers of vitamin A deficiency when vitamins are omitted by oversight. This syndrome is not to be confused with *Infantile cortical hyperostosis* or *Caffey's Disease*, although future observations may be made which would establish a relationship between these two entities (167) (see Figure 11).

Clinical findings of this entity include painful swelling of the extremities, with forearms and feet most commonly affected; irritability; pruritis; hepatomegally; inability to stand; alopecia; fissuring of the lips; constipation and inability to gain weight. Laboratory findings include elevation of the serum vitamin A above the normal range of 50 to 200 U.S.P. units per 100 c.c., with typical levels ranging from 660 to 2500 units. (199)

Apparently the body can tolerate quantities of vitamin A 100 times greater than the daily physiological requirement, but there is a definite possibility of harm from the *prolonged* ingestion of vitamin A in excess of 50,000 I.U. daily. Snively writes that doses of vitamin A which have produced the syndrome of hypervitaminosis A have been high—from 80,000 to 550,000 units daily for periods of 2 to 36 months. Of much interest was one child who was given 500,000 units of vitamin A daily for 4 months, yet did not develop the syndrome. This instance and other observations would indicate that there are individual variations in susceptibility, sometimes familial. (199)

*Iron toxicity* has become a recognized entity, with 67 articles in the literature since 1947 reporting this problem and with more than half of the reported cases being fatal. Most of these patients have been infants and children and most have been the accidental acquiring of the iron medicaments unwittingly, as happens with other dangerous drugs. The margin between therapeutic and toxic



Fig. 11. Roentgenogram of patient with Hyper-vitaminosis A. There is periosteal thickening along the radial surface of the ulna with spur formation proximally on the ulna and some degree of osteoporosis. (V.P., 22 months old had refused solid food for months and drank only milk. She had had 15 drops of Mead's Oleum Percomorphum prescribed but received 1 teaspoonful of this preparation for over a year by an over-solicitous grandmother in addition to an iron and calcium compound. The symptoms of pain on pressure over the lower arms, and lassitude, dramatically subsided; and the findings on x-ray disappeared on follow-up examinations within several weeks, with no treatment except the exclusion of the vitamin intake. Roentgenogram supplied and diagnosis made by Dr. Harvey White, Attending Radiologist, Children's Memorial Hospital, Chicago. Patient of Dr. R. F. Grissom and admitted to service of Dr. L. M. Hardy.)

doses of iron seems to be narrower than has been appreciated (82, 134) with as few as 10 five-grain tablets having been reported to cause death (44). The pathological changes in the body have been accompanied clinically by shock and collapse, with the tissue damage occurring in the liver, kidney and mucosa of the gastrointestinal tract, the toxic hepatitis around the portal tracts and iron deposits being the essential liver findings. A new form of iron, an iron choline citrate compound is said to supply iron similar to the manner in which the body binds the metal during absorption and storage without the penalty of systemic toxicity (142).

**Choice of Vitamin Products.** Since there is a plethora of preparations in many physical forms by many manufacturers, accredited and otherwise, and bombarded daily by the literature extolling their many products, the physician faces a dilemma in deciding which product he should use. There was a time when only a limited stock was available to choose from, but there are now many qualified and reliable products. It is not within the scope of this manual to list the products, nor to recommend any one of them. The author can be of help by relating the practice which he and many other pediatricians have embarked upon, and let the reader decide for himself.

The tables of minimum requirements and recommendations are presented at the head of this chapter. Any product must be labeled as to its vitamin content as proscribed by the U. S. Food and Drug Act. Knowing the requirement of the infant, and ascertaining the dosage of the product in question on the label, it is then an easy matter to decide, depending on the number of units or milligrams per dosage form, whether that be tablets, drops, teaspoons, cubic centimeters or capsules, and whether in aqueous dispersion or oily menstruum. Consideration of tolerance of the product or the ease of administration should dictate the selection provided, of course, that the vitamin requirement is met. One product is superior to another only in the ease with which the infant or child receives it, as well as the manner in which the gastrointestinal tract may tolerate it.

Glaser, *et al.* (loc. cit.), as well as Eliot and Park (18) substantiate the general conclusion that in human nutrition, the various types of vitamin D commercially available are, unit for unit, indis-

tinguishable from each other. The first named authors, cited in their study on premature infants, concluded that there appeared to be no difference in the efficacy of the vitamin D preparations in preventing rickets or in allowing growth. The crystalline vitamin D<sub>2</sub> was no better than the noncrystalline forms, and there was no superiority of vitamin D<sub>3</sub> over any of the vitamin D<sub>2</sub> preparations used.

If any product or the reliability of the manufacturer is in question, the listings of the vitamin preparations accepted by the Council on Pharmacy and Chemistry of the American Medical Association may be consulted. In addition to the acceptable products as stated above, there are over 100 other preparations advertised in various medical trade journals, of which there is no official information as to their reliability except the word of the manufacturer, and the claims made for them are under the jurisdiction of the Food and Drug Act of the U. S. Government. More security is felt by the physician who has neither time nor resource to seek out the true facts, if there is some official status of the product, and if it is prepared by a reliable, ethical, and time-tested manufacturer.

*Vitamin C* is administered to infants and children in the form of ascorbic acid and may be found in many of the natural juices as well as in the fortified infant juices now economically available (*see Appendix*). Ascorbic acid may be administered alone or in combination with other vitamins, the latter being the usual custom. Many reputable proprietary-named products combining vitamins A, D and ascorbic acid in aqueous preparations are available, which eliminate the multiple administrations of recent years, and serve well the infants' simple requirements of these three specific nutrients.

(Dr. H. Medovy of the Children's Hospital, Winnipeg, Canada, suggests that the addition of ascorbic acid to evaporated milk would solve the growing problem of scurvy in Canadian infants and adults. For experimental purposes evaporated milk was produced which was fortified with vitamin C at a level to provide at least 100 mg. per reconstituted quart. Even after one year of storage under adverse conditions this level of vitamin C remained unchanged. Two infants with scurvy were treated successfully solely by this type of milk. Dr. Medovy states: "The

incorporation of vitamin D in evaporated milk proved to be an all-important factor in eliminating rickets due to vitamin D deficiency. The addition of vitamin C should be just as effective in eliminating scurvy" (105). (See also Grewar, D.: Scurvy and its prevention by Vitamin C fortified evaporated milk. *Canad. M.A.J.*, 80:977, 1959).

### CLINICAL COMMENT

It was indeed unfortunate that the investigator Casmir Funk and other early bio-chemists settled on the name "*vita-min*" when they were searching for a term to give to a specific nutrient. The connotation was implied as that of its Latin origin - "*vita*" meaning "*life*." It was also assumed that these substances were chemically *amines*, so they combined the implication of "giving life" with a chemical suffix, and they were wrong on both assumptions. *Vitamins* are food factors, substances only found in natural sources, and produce symptoms and pathological changes only when they are not present in the food intake of an animal or human being over variable periods of time. Subliminal or more manifest bombardment of the health-conscious public has made the term "vitamin" a magic word, and frequently some alert entrepreneurs have risen to the commercial and exploitive challenge. Even intellectually-honest physicians have been led to spurious conclusions and they interpret the implication of the meaning of the word "vitamin" as synonymous with the old-fashioned term of "tonic."

These specific nutrients, *the vitamins*, can only be of help to any organism *when it is deficient in an adequate diet*. The Council on Foods and Nutrition of the American Medical Association has again stated recently that: "Vitamins are essential nutrients, and their usual source is food. All of the nutrients essential to the maintenance of health in the normal individual *are supplied by an adequate diet*, one which fulfills the Recommended Dietary Allowances (131). . . . They are believed to be adequate for maintaining good nutrition throughout life" (37).

Accepting these tenets as the most authoritative available, this limits supplemental vitamin administration to the following:

a) To infants whose dietary is restricted in ratio to growth needs, essentially vitamins D and C;

b) To periods of debility of any individual during prolonged abstinence from an adequate or balanced diet, as in disease states;

c) To certain economically-indigent, or provincially food-conditioned nationalities in the world—like those who must live on inadequate intakes mostly of starch, or the one-diet groups who are early indoctrinated to the custom of their native foods and who persist in these “ethnic flavors” even in the presence of better balanced diets. Other than in these specific indications for additional vitamin supplementation, “shot-gun” prescribing based on wishful-thinking or ignorance of scientific facts continues in many medical circles with consummate faith and apparent confidence that a need exists.

In February of 1959, Mr. Arthur S. Flemming, Presidential Cabinet Secretary of Health, Education and Welfare of the United States Government, announced a “crackdown” on the “most widespread and expensive form of medical quackery in the country today”—misrepresented vitamins, minerals and other food supplements. He further stated: “The American Medical Association estimates that this racket is now costing 10 million Americans more than \$500 million a year.” Another quote from this cabinet member is “. . . the results can be tragic when unknowing or unscrupulous promoters distort the facts and claim benefits for their products far beyond the actual results. I will do everything I can to assist the Food and Drug Administration in the enforcement of the law against those who deliberately seek to deceive the people with false claims and theories.”

An illustration of the utterly inane advertising copy which is directed *even to physicians* is the following, taken from a trade organ of one of the leading pharmaceutical manufacturers in this country on July 15, 1959: It is headlined—“TWO OUT OF BED . . . ONE OUT OF B<sub>6</sub>” “The wakeful baby who turns father into a floor-walker may simply lack B<sub>6</sub>. Infant formulas and mother’s milk may fail to provide sufficient amounts of this ‘happy-baby vitamin.’ OTHER B<sub>6</sub> DEFICIENCY SYMPTOMS: irritability, regurgitation, gastric pain, convulsions.” One is impressed with the copy writer’s appraisal of the apparent naïvete and gullibility

of the physician to whom the advertising is beamed. The reaction of most physicians is that of being offended, and to make a mental note to remember *not ever* to prescribe any vitamin preparation of this particular company.

Via radio, television, newspaper, magazine, billboard and other forms of advertising media, the medicine-taking and vitamin-conscious public are constantly being extolled to evaluate vague symptoms which "might be" helped by vitamin supplementation. The snake oil vendors and medicine show men of former years never had the rich opportunity at exploitation of human credulity than the promoters of the present! These pitfalls have been recognized by scientific investigators for many years and have brought forth many remonstrances by these authorities. Dr. Anton Carlson, world-respected physiologist and diet authority stated: "Those who can afford to buy them (*vitamins*) do not need them." Dr. Philip Jeans of infant nutrition fame has repeatedly stated that when a diet is deficient in any one vitamin it is also lacking in many other essential factors and more is needed than the supplementation of any one specific nutrient.

Lest the reader, especially the novice in medicine, think that the author is "riding a hobby" and using this book as a rostrum for the advancement of a kind of therapeutic nihilism or a denouement of that which has been so arduously wrested from Nature in nutrition research, let him observe the following editorial. This timely summary (May 1959) of the vitamin question is succinctly condensed in an editorial by the editor of *PEDIATRICS*, Dr. Charles D. May. This journal is the specialty organ of the American Academy of Pediatrics and would convey the impression that the statements made here represent the opinion of the distinguished Editorial Board, the Committee on Nutrition of the Academy as well as that of the Editor who in his own right is a research nutritionist of recognized authority. The Editorial is here quoted in full excepting the deletion of the portion quoted from the A.M.A. Council on Food and Nutrition, the reference of which is given:

### **Vitamin Supplements**

The selection of the supplementary vitamins that may be needed should be one of the simplest things the physician has to

do in prescribing the diet for an infant or child. At least one would be inclined to believe scientific nutrition must have progressed this far. And yet confusion and wasteful error characterize the customary use of vitamin supplements in academic centers as well as by practitioners. Why?

The remarkable variety of commercial preparations of vitamins now available makes a choice difficult. Without elementary knowledge of the vitamins needed to maintain the health of normal infants, in contrast to the unusual requirements in disease, it is easy to yield to the temptation to give every infant and child a superabundance of vitamins in an all-inclusive supplement—just to be sure.

Such casualness amounts to lavish generosity. In 1957 the sale of vitamin concentrates in the United States amounted to \$250,000,000 in drug stores and an additional \$180,000,000 in all other outlets. The annual total expenditure for medical education has been estimated at \$200,000,000. If there need be a fear of widespread deficiency, it is not of vitamins!

The confusion is intensified by claims for unique (but insignificant) advantages for many of the preparations in respect to a particular assortment of vitamins, solubility or other physical properties. Close reading of advertisements is required to avoid being misled by the implications of such terms as basic, essential and significant, sometimes applied to combinations of increasing complexity.

Every physician will welcome the clear, thoughtful guidance through this man-made maze that is contained in a recent report prepared by the Council on Food and Nutrition of the American Medical Association (Vitamin Preparations as Dietary Supplements and as Therapeutic Agents. *J.A.M.A.*, 169:41, Jan. 3, 1959).

All of which may be summed up by stating: A normal infant requires no more than 30 mg. vitamin C and 400 units vitamin D in supplementation of his mother's milk or his artificial formula. (Some prepared formulas include enough of these vitamins.) Normal children should receive 400 units vitamin D, either as a supplement or in vitamin D-fortified milk. Supplementary vitamin A and the B complex are not recommended for ordinary feeding practice, but only in exceptional circumstances of disease and special problems. A supplement is a supplement and not the whole source of supply.

Don't fall prey to a play upon words, such as optimum and re-

serves, or be driven into lavish and foolish ways by disquieting queries, such as: How does one know an infant is normal or has the usual requirements? And don't get the ancient tonie habit all over again just because of publicity given to an occasional under-par child who won't eat.

Save the people some money to buy food and more education!

**Summary.** Having presented the essential facts pertinent to the accepted and modern knowledge of vitamin administration in infants to the present time, a summary of the real needs of an infant who is presumably receiving an adequate food mixture should be presented. It is repeated again for emphasis that the connotation "*normal infant*" is used with reservation. "*Normalcy*" is immediately excluded and the realm of pathology encountered when any infant is deprived of human milk and is bottle-fed (18). It is also repeated that the outline given in Table 37 is on the presumption that all factors of the diet are adequate to the infant's needs. A diet deficient in the vitamins not listed is deficient also in other nutritional demands. The obvious solution is a more adequate diet, not medication. What has been postulated about the infant's requirements does not follow through childhood and adolescence when the demands are other than in infancy. The facts are presented applicable to infancy, since this is a treatise on infant feeding.

The recommendations of Table 37 are made without calculating the intake of vitamins in milk mixtures or foods. To compute daily the contribution of any vitamin in milk or food is not only impractical, but also inaccurate, due to the variable quantity of

TABLE 37  
SUMMARY OF VITAMIN NEEDS OF THE FULL TERM INFANT

	Vitamin	Dosage	Age to Begin
Breast-Fed	C	30 mg. (a safeguard, not required)	4 weeks
	D	400 I.U. (not more)	2 to 4 weeks
Bottle-Fed	C	50 mg.	2 weeks
	D	400 I.U. (not more)	2 weeks

food consumed as well as the hazards of the immediate home preparation, since the stability of the vitamins may be affected by heat, exposure, and refrigeration. It is presumed that those commercial bottle-fed foods which have vitamins C and D included will suffice for the needs. The required intake or quantity of food ingested would of necessity be accurately observed and additional amounts perscribed—so that a sufficient dosage might be assured.

In conclusion, it may be stated that the generalizations made in this section on the general subject of vitamin administration are not the opinions of the author alone. Each of the statements can be corroborated by authoritative sources in the current literature appended in the bibliography of this book. It is also repeated for emphasis that the recommendations and observations made are those limited to *infants*, and that the author has no official opinion regarding their application of vitamin prophylaxis and therapy in age groups above that of infancy. However, the reader may apply the data given to other age levels if they are found compatible and pertinent.

*The desire to take medicine is perhaps the greatest feature which distinguishes Man from animals.*

SIR WILLIAM OSLER

(Harvey Cushing: *The Life of Sir William Osler*, Vol. I, Chap. 14.)

## *Chapter Ten*

### CLINICAL TRIVIA AND PHILOSOPHIC OBSERVATIONS IN AN EVERYDAY FEEDING PRACTICE

IT is suggested that those readers of this section who have been in practice for more than ten years would not pursue their curiosity further into this chapter. It is a homely melange of everyday minor problems and situations which the experienced physician would find trite indeed, for he has developed "pat" answers and standard solutions for the endless variety of situations which arise many times daily. Not so fortunate is the neophyte who, in the welter of scientific lore which he has brought from his medical school and hospital training, finds himself at a loss and slightly disillusioned in the endeavor to correlate the academic with the applied and practical. It is for these newcomers that this chapter has been added without apologies, because it contains trivia and the philosophical which the new physician finds difficult to separate from the essential and scientific.

It is hoped that a perusal of this chapter will help the younger practitioner to surmount some of the hurdles which seem nebulous to him now. This is part of the art of medicine, reduced to a common homely denominator. It is an obligato of the commonplace with a scientific background accompaniment which lends it some semblance of factual theme. It could have been written by anyone in practice dealing with infants and children who would care to be so articulate and yet not ashamed to expose the small artifices he has invented to deal with the tedium of a practice. It will not be found in any other medical textbook because it is considered unerudite, and yet it is one of the many facets which make up a satisfactory integration of ideas to those who need complete instruction in this or any subject.

## MINOR GASTROINTESTINAL PROBLEMS

The infant gastrointestinal tract is heir to many minor disturbances in addition to the major errors of embryology, possibly because it is one of the physiological systems which is most underdeveloped in infancy. The following entities will be dealt with as symptom complexes rather than true pathologic states. They can rarely be accurately diagnosed or given definite names in accepted nomenclature, and are evanescent in time and sequelae.

### Regurgitation of Gastric Contents

This is a symptom-entity with many minor origins. It is common to any infant disability and may be considered a *herald sign* of what may later develop. Vomiting appears after body injury, emotional disturbances or cerebral shock, and it initiates almost all febrile diseases. It should be taken as a signal that the stomach is intolerant to function, and certainly more digestive effort in the way of additional food is contraindicated. If vomiting persists, *cyclic vomiting* may ensue, which in an infant may set the stage for the ominous signs of dehydration and electrolyte disturbances. Milk, because of the curd state, taken orally during vomiting from any cause is well known to excite more vomiting at any age and should be the first food to be discontinued during an established vomiting siege.

The most common and usually harmless regurgitation by the young infant is most often of mechanical origin such as air swallowing, and the reader is referred to Chapter 7 where the subject is discussed at great length as to the bottle-fed baby.

Another harassing problem is the "professional spitter-upper" who is not ill, is gaining weight, is happy and taking food voraciously, and yet continues to regurgitate any time after feedings. This occurs usually in the very active infant from 1 to 7 months whose every twist and turn of the body is a "cataclysmic" tremor which presses on the abdominal wall with a resultant eructation of food. One is reminded that he may be closely related to his ruminating forebears, and has for some atavistic reason, retained this dubious talent and is not disturbed by this evolutionary relationship. Although this type of regurgitation is of minor medical

import, it becomes a momentous complaint on the part of the parents when every piece of furniture in the home and the last clean shirt of the father and all of the wearing apparel of the mother reek of infant stomach contents. Parents are usually somewhat placated when it is proven to them that it is not faulty digestion of food which causes this difficulty but *activity*, because it only occurs while the baby is active but not when asleep—a valuable differential point. Frequent changes of the milk formula mixture bring no surcease from this exasperating act. Feeding with a cereal-thickened milk formula to a heavy consistency and fed through a half-inch sized nipple hole often lessens the vomiting, as does the addition of other solid foods of the first year. When the baby has acquired the ability to sit erect with support, this habit is usually aborted merely because of gravity since it is more difficult to eructate vertically. Elevating the bed or mattress to about 15° which raises the proximal end of the esophagus above the level of the cardia of the stomach will often reduce the amount of spitting-up for obvious mechanical reasons. Pyloric stenosis or central nervous system vomiting is more dramatic and projectile and should not be confused with this innocuous type just described. In the functional vomiting the vomitus “wells” out of the mouth while in the more serious organic origins it is forcibly projected.

### **Bowel Movements of Infants**

The studious examination of infant stools by physicians and medical investigators has become a “lost art” and does not seem to be as important at present as was once emphasized. Indeed a writer (97) recently in a facetious vein commented at length on the demise of “stool gazing” and is quoted in part herewith: “Until recently, infants’ stools had been studied with a devotion paralleled only by the passionate zeal with which the Babylonians studied the liver. . . . In the 1920’s the cult, then graced by the term “clinical coprology” had reached its zenith . . . the era of the stool gazers and diviners is past!” However appropriate these observations may be, we still have a few clinical indices to adjudge the results of digestion as observed in the character of the stool.

*Approximate Norms in Bowel Movements.* The breast-fed in-

infant has a stool which is always characteristic and should be examined by all medical personnel who have to differentiate the normal from the pathological, such as nurses, nursery attendants and internes. This stool has characteristics which are the converse of the so-called normal requirements of the bottle-fed baby diaper content. The human milk stool is loose, wet, contains various-sized soft curds, has a sour milk odor and glistens with mucous. It is often recorded improperly on the chart of the nursery newborn baby by the uninformed as a "diarrhea" stool when, it is normal for an infant who is breast-fed. The average normal bowel movement of the bottle-fed infant is smooth, homogenous in texture, of putty consistency and can be peeled from the diaper without leaving a stain.

*Abnormal Bowel Movements.* There is a *frothy stool* which is explosive and blown full of air bubbles. This usually indicates too much fermentation and usually can be adjusted to the norm by either lessening the proportion of CHO additive in the milk mixture, or changing to one with more dextrins and less disaccharides.

The loose stools which may accompany *parenteral or intestinal infections* are loose or liquid with a great deal of mucous and perhaps blood. They may be light in color because the bile has less time to mix with the intestinal contents, and they usually have the characteristic of burning the skin of the buttocks. This condition is often self-limited, but when persistent they should be cultured for specific causative organisms.

There is a clinical entity in which there is a kind of persistent loose bowel movement that is found to be some degree of *fat or starch intolerance*. It is ill-defined from a laboratory standpoint but free fat globules or undigested starch may be detected in it with simple tests. These are not always forerunners of the intolerances classified in the celiac syndrome but occupy a vague area between the normal and the celiac groups. These erratic states here referred to can be easily corrected by the use of *Protein Milk* for a period of weeks, and often the offending agent (fat or starch) or a full diet can be added under the protection of this pre-digested milk.

*Remedial Measures in Persistent Enteritis or Loose Stools.* The

care of the usual and probably self-limited loose stools following parenteral infections is simply to offer a reduction of the formula mixture both in total solids and in CHO; or in the older infant to substitute boiled skimmed milk for the duration of the indisposition. Exclusion of fruit, fruit juices and vegetables as well as the fatty increments of the diet will be an adjuvant to the treatment. The use of anti-diarrheal medication is usually unnecessary in the milder types of enteritis. When the resultant bowel infections persist, or the bowel becomes irritable or inflamed from a prolonged infection, then many of the pectin containing or bismuth preparations may be indicated. If the inflammatory state of enteritis persists, many of the products listed in Table 26, Chapter 5 (Therapeutic Adjuncts) may be indicated. These include PECTINAGAR with DEXTRI-MALTOSE<sup>®</sup>, PROBANA<sup>®</sup>, KANANA<sup>®</sup> BANANA FLAKES, AROBON or APELLA<sup>®</sup> for the prolonged irritation or inflammatory mucosa of the infant intestine. The author finds that CASEC<sup>®</sup> is almost indispensable as a help in treating these non-specific entities. It is added directly to the usual milk mixture with or without a CHO additive until the bowel movements have become more formed.

*Hard Stools in Infants.* This state in an otherwise normal infant is never serious but a source of anxiety to the parents. When they are described as "like marbles," "rabbit stools" or "pebbles," too little fermentation may exist or from the presence of hard calcium soaps from the fatty acids liberated in digestion of the fat. These conditions can easily be ameliorated by correcting one of these deficiencies. More bulky food like cereals may be added; more of the easily fermentable disaccharides like maltose (MALT SOUP EXTRACT); by adding DEXTRI-MALTOSE<sup>®</sup> #3 (which contains 3% potassium bicarbonate which counteracts the calcium soaps); or perhaps by the simple expedient of adding fruit or fruit juices 2 or 3 times per day as part of the regular diet. The word "constipation" is neither a noun nor an entity in infant feeding as contrasted with the adult organism. The infant under 2 years has not lived long enough to become functionally "constipated."

### **Hunger as a Symptom**

Persistent crying, failure of weight gain and scanty stools in an

infant is a triad of symptoms which should be easily recognized as *hunger*, and something should be done about it. Dr. Joseph Brenemann was of the impression that 80% to 90% of the crying of infants was probably due to hunger. Often the green and scant curd-containing stools infers incorrectly to the medical observer that the child has an enteritis or food intolerance. The mixture is then lessened by reducing the milk base by greater dilution and even the quantity fed is smaller. This leads to more of the same difficulty and no end is served. One should at least give the infant the test of a more potent formula mixture, and more in quantity should be offered when these symptoms appear.

### Over-Feeding

This is a will o' the wisp diagnosis which is seized upon by those who are desperately groping for an answer to the hunger syndrome. Other than when the total solids are increased beyond the ratio usually accepted as standard, or when the infant is permitted to take some feeding every time he cries—other than with these two possibilities *over-feeding* is not a clinical probability. The human infant, although greatly inferior in size and maturity to his mammalian newborn counterparts, is equally as able to determine his capacity of food at one feeding. It is practically impossible to make an infant take more than the stomach will hold. Milk mixtures for the bottle-fed infant, as well as with the breast-fed babies, are calculated to accommodate an infant's capacity in quantity.

### Food-Induced Rashes

These are not as frequent as the laity would account for them. Other than urticaria immediately following the ingestion of a specific food, or the appearance of an eczematoïd rash on contact with the skin or some hours later, are the only entities which will fit this category. The specificity of the induction of a rash by an offending food would have to be repeated several times before that food could be incriminated. The conventional foods thought of which produce this reaction are usually: egg yolk or egg white, citrus fruit juices, nuts, chocolate, oatmeal, spinach or any leafy vegetable. Well-controlled tests should be done before an important food (like egg) is eliminated.

## PRACTICAL HINTS ON FEEDING THE PREMATURE INFANT

Any detailed discussion as to the care and feeding of the premature infant *per se* has been deliberately avoided in this book except for various references which cut across general infant feeding. It was announced in the Preface as well as in the first chapter that this text will deal with the *normal, average* baby. The deviation from the *normal* is immediately made when an infant is precipitated into the world before normal and mature physiological reactions are present. Several general hints involving material and data which apply to full-term infants are applicable and are briefly presented here.

### *Too-Early Feeding of the Premature Infant*

Authorities in this field of prematurity of the human neonate agree that many an infant has been fed too early when all of his capacities for living are already being taxed to the limit. Any efforts at further weight loss and a vain hope of stimulating the premature baby with food are born of over-zealous physicians and nursery personnel. There can be no absolute rule promulgated as to age-in-hours which would cover all situations since the individual infant's state of anoxia, temperature instability, respiratory effort and general status of immaturity would be the controlling criteria. The author has been emboldened by experience in usually *not offering anything by mouth* until 72 and often 96 hours, and has had the tremendous satisfaction of never, to his memory, being regretful for this position despite the gentle and sometimes overt restlessness on the part of some of the premature-station personnel. If any evidence accrues of minimal urinary output, this can be circumvented by small amounts of fluid (50 c.c.) under the skin. As a practical rule, not substantiated by any controlled studies but by clinical experience, it is prudent not to complicate the immature infant with the tasks of swallowing, digestion, and ingestion of food when his efforts are consumed by the cardinal job of staying alive.

### *Need of the Premature Infant for Calcium Supplements to Food*

As was stated on page 208, the concept that the premature infant requires more vitamin D than the usual dosage (400 units per day) is erroneous even though this type of infant often develops sub-clinical or frank symptoms of rickets. The reason is a *deficiency of calcium and phosphorus* rather than in an increased need for vitamin D. An infant, premature by only one month, has only half the amount of calcium deposited in his skeleton than if carried to full term. This degree of amineralization should be reckoned with in prescribing the food for the infant after the preferable period of 72 to 96 hours. If any milk mixture, and if human milk is fed to the premature baby, both should be supplemented with dietary sources of calcium which then permit the vitamin D to act as the activating or "catalytic" agent for mineralization.

This addition of calcium to either human or any bottle-fed infant food which is prescribed can be easily achieved in a practical way by including in the formula mixture or human milk, 2 to 4 tablespoonfuls of any dry skimmed (nonfat) milk. The commercially-prepared product Casee<sup>®</sup> (Mead Johnson) may also be used for this additional source of calcium. Both additives mentioned would also contribute added protein.

4 tabbsp. Nonfat (dry) Milk would add: 500 mg. Ca; 11 gm. protein.

4 tabbsp. Casee<sup>®</sup> would add: 300 mg. Ca; 16 gm. protein.

Thus either of these two supplements would provide additional calcium and protein to that already found in the respective vehicle-mixture prescribed, and would come much closer to the premature infant's needs than any human or formula mixture ingested alone.

### AN APPRAISAL OF SO-CALLED "COLIC" IN INFANTS

Every physician engaged in the care of infants will inevitably meet the neonate with the syndrome known commonly as "colic," and unless he has some method of recognizing, explaining, prog-

nosticating and managing this entity he will not survive long as that infant's medical advisor.

### Varied Terminology

Much has been written concerning this symptom complex, and folklore and home-spun advice are rich in the "diagnosis" and care of this type of baby. Because no mortality attends this entity and because it is self-limited after 3 to 5 months, no serious research has been directed toward the understanding of this infant's difficulty. It has been called by many names (in addition to those appellations hurled at it by weary attendants). It has been explained as: *enteralgia*; *spastic bowel*; *enterospasm*; *enteric hypertonia*; *over-active parasympathetic nervous system*; *immaturity of the gastrointestinal system*; *vagatonia*; *low threshold to sensory stimuli*; *imbalance of thyroid and adrenal glands*; *enlarged thymus*; *disturbance of the calcium-phosphorus metabolism*; *hypoglycemia*; *hypoproteinemia*; *pyridoxine deficiency*; *allergy to cows' milk*; and *paroxysmal fussiness engendered by faulty interpersonal relationship between the infant and his environment* (11, 12, 13, 181).

This condition is rarely seen in the completely breast-fed infant; is common in the first-born child in a family; has a greater incidence during times of economic distress or national emergency; and is rarely met with in a hospital. Levin, in a review of 645 charts over a 3-year period in the New York Foundling Hospital (29) did not find a single case of "colic" reported by the medical staff. Indeed, as Ratner so aptly has stated, "... we might define 'colic' as a *protean* disease not often due to proteins" (29).

With all of the above descriptive terms designed to account for this syndrome, it would seem futile to offer another explanation or theory. This discussion is not intended to contribute anything toward the etiology of this common complex, but an effort is made here to present a workable approach to its understanding, its management, and to offer a prognosis of this type of infant on his progress through life which reflects this early state. Until adequate controls can be determined whether an anatomic pathological state exists, or that there is a proven physiologic dysfunction in these infants, it is justifiable for us to assume that they are physically normal. They deviate only from the expected or conven-

tional behavior because, as with adults, they vary in temperament, reaction to sensory stimuli and motor responses. The personality variants of the adult organism are accepted as standard behavior patterns, but infants are classified too rigidly into one expected groove. The immaturity of these babies limits their means of expressing reaction to their environment and to auditory, visual and other stimuli.

### Gastrointestinal Allergy as a True Entity

There is one proven organic entity in this symptom-complex which may be identified and accepted as a cause of "colic," and as such offers an effective relief from the distressing symptoms. The incidence of this one scientific increment of this syndrome which can be isolated and defined varies from 10% to 40%. In the author's experience it has been only 5% or less. Fries, an allergist of repute and a practicing pediatrician as well, would place the figure of children with a proven allergy to milk, by strict criteria, at about 0.3 per cent. (195) It is well to consider allergy to the food protein in every infant with the symptoms of "colic" and it is not unwarranted as an experiment to exclude the cows' milk protein molecule by the substitution of other protein sources.

The symptomatology of "colic" caused by allergy is about the same as that caused by an emotionally unstable family background; but in infants with the former condition, on laboratory examination of the peripheral blood there is an increase of the *total* eosinophil count (normal, 50 to 400 per cubic millimeter), as well as a *relative* increase of the eosinophil count of the polymorphonuclear leukocytes. The preponderance of eosinophils has also been demonstrated by a count of 100 cells found in a smear taken from the mucus of a stool. The diagnosis is proved by the dramatic and usually permanent alleviation of symptoms which results from giving the infant any one or more of the 14 available hypo-allergic commercial or bottled fluid milk mixtures.

### Interpretation of Symptomatology

The cry of "colicky" infants is loud and continuous, impelled not by emotion but as a kind of rhythmic motor expression. As someone has said, "They seem to breathe with the vocal cords

held tautly," since the cry is without tonal variation and is merely one long expiratory sound limited only by the lung capacity. The desire to exercise the sucking drive by grasping at even alarming quantities of anything offered them is not necessarily hunger, as the layman believes; it is merely an effort *to be doing something*—an exit for pent-up energy.

These infants are always described as demonstrating abdominal pain, an observation which is based not on proof but on the fact that they universally are said to pull their legs against their abdomen. It is not accepted that an infant at this age can localize pain, abdominal or otherwise. The only way he can move his legs is by extension and flexion. Pulling his hair, pricking him with a needle, or causing him any other discomfort will result in the identical excursion of the extremities, which always includes waving of his arms (a fact which never seems to evoke the same inference as does the motion of his legs). Due to the vehemence of their sucking efforts, "colicky" infants also swallow an excessive amount of air, which, in turn, is ejected along with ingested milk. Hence, such infants are prone to regurgitation. Pylorospasm is almost always associated with the hypertonic infant, and vice versa (12, 13).

One of the classic observations made by parents is that this type of baby "passes more gas" than is expected; therefore, they think the food is at fault. Yet the stools are formed and there is no evidence of excessive fermentation. The baby merely holds the sphincter ani tightly so that the passing of flatus, which normally is constantly occurring, does not take place. When the intrarectal pressure becomes too strong for the anus to withstand it, the bolus of air (gas) is ejected with force and sound. This leads to the erroneous inference that the food mixture is too fermentative. Rectal dilators may be inserted, but they only *add* to the infant's distress. The baby seems to resent any sphincter action, or, perhaps, he is startled by these normal automatic functions. Much straining accompanies the passage of even the soft normal stool, and the baby may even act startled and cry sharply at the action of the urinary sphincter.

Associated with the symptoms just mentioned is the immediate and demonstrative response to sensory stimuli. The reaction to sound or sudden light is accompanied by an immediate and sometimes violent response of the startle reflex. Reaction to a sudden

change of position, such as being placed on his back, or to the falling reflex, which excites the Moro reaction, is always accentuated in this type of infant. None of these reactions are abnormal or of a pathologic nature; they are merely *exaggerated* and thus can be accepted as within the normal range of behavior. One can describe such an infant in such simple terms as tense, vigorous, dynamic, energetic, "wound-up tightly," stimulated, lusty, vehement, etc. These terms are synonymous and are merely subjective descriptions of the way in which this type of infant responds to his environment and of how he will react to more mature surroundings in later life. The child *will remain* the same; only his improved ability to escape the frustrations of infancy which limit his activity *will change*.

### Prognosis of the Hypertonic "Colicky" Infant

If one is interested in the development of human personality and has the opportunity to observe these children during growth, the ultimate destiny of these patterns becomes evident. Such a baby holds up his head early, learns to assume the sitting position at a younger age, and acquires the grasp reflex earlier than the norms demand. His interests are versatile, and he frets early and late at his inability to change from a sessile organism to a mobile one; hence, he soon becomes ambulant. All his motor skills and, often, his mental progress are ahead of his developmental age. He boldly embarks on all manner of projects involving brazen disregard for balance and the law of gravity. Climbing, moving large objects, and lifting incredible weights are some of his activities. Later, at the elementary school level, he is active and usually skilled at sports. He has many hobbies, such as collections, and is usually a good organizer. He collects many friends, whom he directs by physical means or by astute maneuvering to his own advantage. He is aggressive, a leader and nonsensitive to the rebuffs of others. He is seen on the street corner as a patrol boy, and he is chosen early as a representative on the student council. In high school he "runs everything"; he has leading roles in class plays, holds class officerships, and edits the school paper. He often runs afoul of school discipline, not as a deviate but because his enthusiasm carries him too far from conventional and expected behavior. Although he rarely is in trouble academically, he seldom

is the valedictorian, since this is only *one* height to achieve and there are so many others on which to expend his endless energy.

Thus, this hypertonic infant, who early voiced his resentment against the restrictions imposed on his immaturity, rushes through life from one success to another, drinking deeply from the draughts of a vigorous and rewarding existence. He becomes the counterpart of the hypertonic adult who has a multitude of interests and hobbies, a driver at work and games; he is one who needs little sleep to recoup the energies expended and is capable of prolonged and sustained expenditure of physical energy. This type of person is happy and well adjusted, enjoys life to the hilt, is usually highly successful socially and financially, and rarely is found on the psychiatrist's couch or its equivalent. He has outlets to the many drives which were the despair of his immature hypertonic baby days.

### Management

The care of the "colicky" infant, who has his happy future before him, should be regarded not with apprehension and dread but with challenge and patience. Two procedures are necessary to accomplish this task: (1) the careful explanation of his pattern to the distraught and worried parents, and (2) the use of one of the many antispasmodic pharmaceutical agents available to ameliorate the experience—for both the child and his parents.

If ever the *art* of medicine is utilized to its greatest, it is in prescribing for the care of such an infant. Both parents should be separated from their highly vocal ward for this consultation. They must be assured that the infant's pattern of hypertonia does not involve any abnormal condition of the brain or nervous system, since this is often a foregone conclusion with them. It is easy to prove, and as welcome for the parents to accept, that the child is physically normal according to the obvious criteria of adequate weight gain and the ingestion of prodigious quantities of food and judged by the fact that he continues to grow and develop. The parents should be shown that the child's overactivity is within normal limits and that this type of infant is frequently seen. This is easily proved by the many exaggerated physiologic acts which the baby demonstrates. It must be explained to his

parents that everything the infant does is performed at a higher-than-average level because of his keyed-up pattern. The parents should be assured that the child's future is secure and that the very symptoms which presently are disturbing will be virtues when he has grown more mature. There are many homely illustrations of these promises which may be enumerated to the parents. It is at times amusing when these parents later literally recall to the physician some of the seemingly prophetic promises which he made to them.

With this calm and unaffected forthright discussion by the confident physician, all questions concerning the infant's apparent aberrations can be made to fit the description given, and this assurance can be projected to the parents. The little time taken to transmit this feeling of security will save many hours of fruitless trial-and-error explanations in the years that the child is under the physician's care. Doctors who are consulted for this problem find that, regardless of their intellectual level, the parents will always appreciate such a lucid interpretation.

The second step in the care of a "colicky" infant is the concomitant aid offered by the many available antispasmodic agents. It is a truism in therapy that when there is no specific remedy for a given entity, many therapeutic methods are evolved. If only for historical reasons, it may be interesting to list some methods which have been employed. Some stem from the days of pioneer medicine and others from the rich folklore of child rearing. Carminatives, such as catnip and fennel tea, peppermint water, charcoal solutions and cinnamon water have been used. Mechanical adjustments often are tried, such as making the nipple hole smaller or larger or changing to specific nipples with proprietary names which imply that they contain an antidote for colic. Heat applied to the abdomen, whether from the parent's body or by the trusty hot-water bottle, has long been used.

Other therapeutic methods include massaging the abdomen or the bottoms of the feet, use of enemas of every content as often as 10 times a day, use of rectal tubes and catheters to "reduce the gas," and last, but not the least often employed, changing the milk mixture or the components of the available formulas. The last-mentioned method is a frequently-used device which often is

frantically employed in desperation by the doctor; it is an almost endless procedure. There are 75 different commercial milk foods and 26 carbohydrate modifiers available to be used; thus, if a new combination were tried each week, the infant would be 18 months old before all of them had been fed. Long before this would be possible, the condition would have subsided, and the formula being used at the time the symptoms abated would receive the accolade for the cure. This device is seized on enthusiastically by the parents, because it seems obvious to them that the cause of the distress must lie in the infant's digestion. Thus, the physician who has the greatest knowledge of milk mixtures and sugar additives is the one whom the trusting parents believe to be the best informed. Although this procedure causes no real harm, it accomplishes no particular good, so wide is the tolerance of the infant's gastric physiology.

No discussion of the entity of "colic" would be complete without a comment on the mechanical device known as a "pacifier." This nemesis of the '20s and even of the present is looked on as heresy by the present crop of grandmothers who reflect the dicta of their own baby-rearing days. In a series of 28 "colicky" infants, Levin (29) found that in all but three the symptoms attributed to "colic" disappeared as soon as the pacifier was given and accepted. It was suggested that these infants' difficulty was due directly or indirectly to an unsatisfied need for sufficient oral satisfaction. The continued success of this treatment lends itself to the explanation advanced in the hypothesis of *this* discussion; i.e., these infants are determined to express a need or outlet for their energy. Any means of employing their motor initiative is a convenient outlet for their drive. For those who need a directive in this controversial matter, it may be said equivocally that a pacifier is an acceptable mechanical device for treating "colic," if for no other reason than to obstruct the opening from which the cacophonous sound emanates.

There are some 14 or more antispasmodic and anticholinergic agents available to help reduce the "colic," enteralgia, spastic bowel, enterospasm, flatulence, enteric hypertonia, overactive parasympathetic nervous system or any other condition which the literature has labeled "colic." It may be added that, as yet, the

so-called tranquilizers have not invaded this competitive field. Indeed, it is known that at present the only drawback to such a move is the pharmacal one of putting meprobamate preparations into solution, so that it can be administered to infants.

All these proprietary products have their merits, as evidenced by the many reports in the papers, abstracts and advertising brochures of their sponsors (6, 122, 171, 182). The alkaloid atropine has long been known as an old-fashioned smooth-muscle relaxant. It may be conveniently used in doses of 1/1000 gr. per 10 drops of vehicle, with or without the apparent synergistic action of about  $\frac{1}{8}$  gr. of the soluble salt of sodium phenobarbital per dose. It remains the choice of those who have become familiar with its use. The flush or hyperpyrexia, or both, are not too common or ominous and may be easily overcome by adjusting the dose in this mobile form of 10-drop dosage.

According to the individual physician's experience, the relaxation of smooth and skeletal muscle obtained by the preprandial use of any of these preparations produces a welcome change in the stormy course for both infant and grateful attendants. It is important to explain to the latter the exact nature of the medication, i.e., that it is not a true sedative but a *relaxing agent*. Most parents will co-operate with extreme pleasure and without demurring at the continuous medication. However, some parents are satisfied to do without the aid offered by the medication if they know the condition is self-limited; they are happy to wait out the time with this assurance. This period is usually about three or four months; but often it may be six months until the infant matures sufficiently to acquire other outlets for his motor drives.

## Conclusion

Many medical practitioners who are veterans in infant care will concur with this explanation of the "colicky" infant and will find the interpretation in this discussion valid and useful. However, it may not appeal to medical neophytes—the interns, residents and those younger physicians so highly trained in the desire to label human ills with definitive names as pathologic entities. Longer experience and the wisdom that comes with sound clinical obser-

vation will eventually help them to become more liberal in discerning between that which is truly abnormal and that which resists academic classification and specific treatment.

### A BIOLOGICAL PARADOX—THE CHILD WHO WILL NOT EAT

It is a strange anomaly that in the wake of the tremendous strides made in infant feeding in the past three decades, there is a pattern of feeding problems in the older child to offset this great achievement. Over half of the consultations of new patients after the first year, in the average pediatrician's office, deal with *the child who will not eat*. This ironical fact exists in a country where food is present in abundance for all! Much has been written about it, many symposiums have been dedicated to it, and many quasi-solutions have been suggested by zealous manufacturers of vitamins and vitamin-containing foods.

#### Parental Factors of Problem

The problem is psychogenic rather than organic in origin. It stems from the fact that the modern mother reflects, in her elementary grasp of the principles of dietetics and nutrition, an impression of those modern measuring units—the weight scale, the slide rule, and the magic words “*calorie*” and “*vitamin*.” The infant is no longer a human being—it is a repository for calcium, protein, carbohydrate, and fat, garnished with a liberal sprinkling of vitamins, and literally propelled into the gullet of the helpless young. Instinct for food taking, quantity, and personal selection are lost in the cloud of enthusiasm for the “newer knowledge of nutrition.”

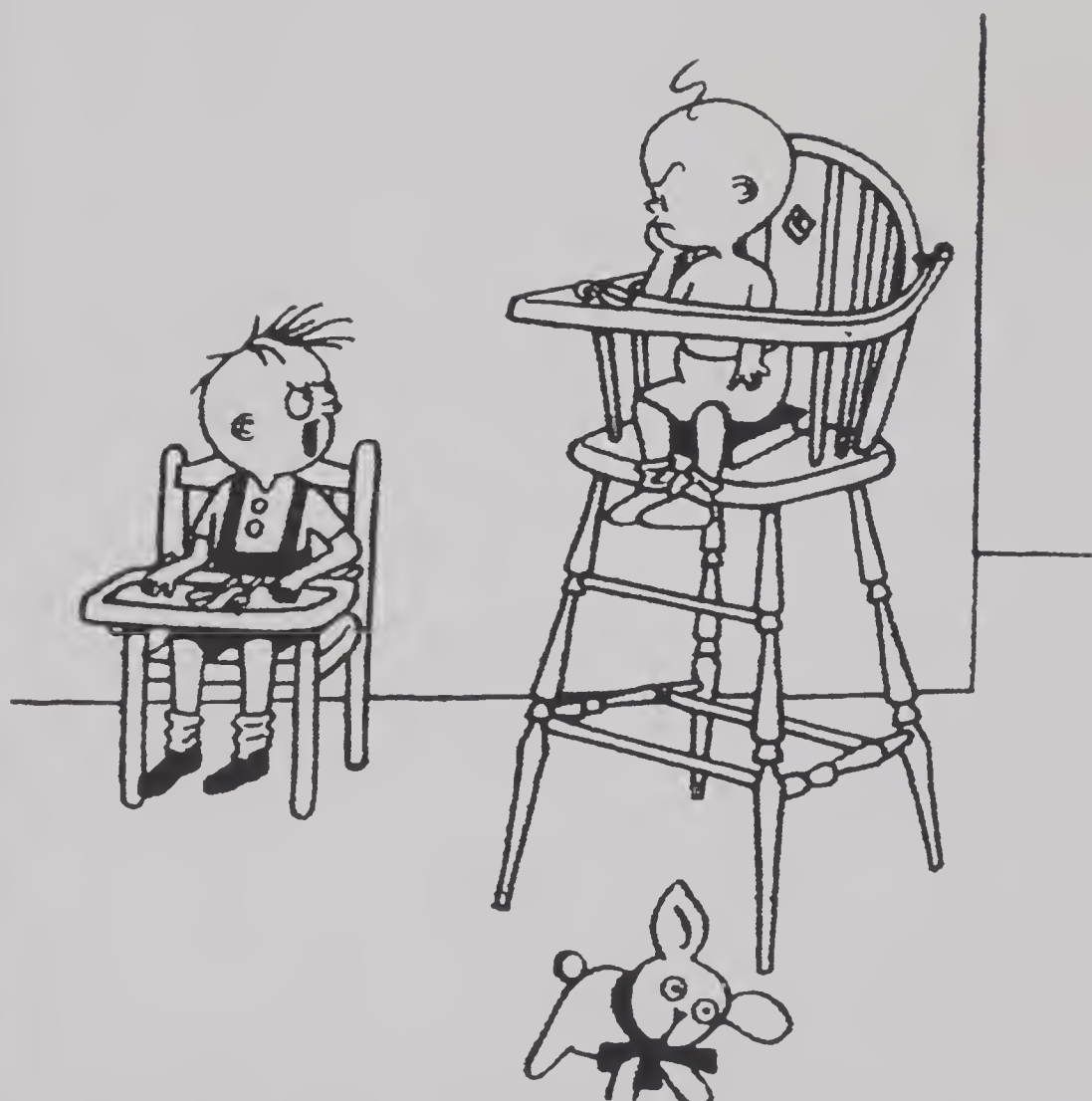
#### Setting

This universal problem occurs usually in the one-child family, or where the children have been separated by years in their entrance into the family. It is rarely seen in the orphanage, in the five-child family, or in the convalescent ward of a children's hospital. It is no respecter of social or economic groups, occurring almost as often at the dispensary level as in the urban or suburban residential community. It is endemic in any mother who is impressed with the modern imponderabilia surrounding the first-

year feeding of any infant. Physicians have had a large share in initiating this complex in the maternal mind, and women's magazines are probably second in responsibility.

### Sequence

Briefly, the problem begins in the newborn period when the last ounce of milk mixture is forced into the helpless infant when he may be satisfied with less. It is enhanced if the baby refuses the last spoonful of cereal or vegetables, when the mother, with



**" I WISH THEY'D START STRUGGLING TO GET  
US TO EAT. I'M STARVED! "**

Fig. 12. (Reprinted with permission of The *Chicago Tribune-New York News Syndicate* and of the cartoonist Roger de Sarro.)

a perverted streak of economy, cajoles her offspring into eating the entire amount prepared. The problem still further evolves when the young child is teased into accepting foods which are new in taste or texture, merely because they have been prescribed, or are "*high in calcium and iron.*"

The final denouement comes at about the fourteenth month when negativism is demonstrated, and the infant develops subtleties and schemes of his own defense to protect himself from the tenacious tentacles of that octopus—*mealtime*—which arrives three times a day. By sheer weapons of resistance—as vomiting the food which has been so patiently proffered, or by the pleasanter and more rewarding route, by observing that the technique of refusal pays premiums—does the baby try to solve his dilemma. Many parents feel relieved when a meal has been stowed away with the help of a story, an animated act on the part of a doll or bear, or more often by a feat of gymnastics on the part of the tired father or any visiting relative. Little do they reckon with the ingeniousness of their offspring! Little do they suspect that the child accepts these entertainment offerings as a *price for eating*, and that when he tires of the same overture, the premium is raised on the unsuspecting and weary parents.

### Prevention

This entire sequence can be interrupted or prevented entirely by the constant propaganda on the part of the physician from the first time he meets the mother in the newborn period. By constantly conditioning her mind toward the doctrine of *laissez-faire* regarding food quantity and food variations, he initiates the first step. Emphasis is placed on the variety of food available that may be *offered* the child, and not the quantity. The relative importance of milk as an *accessory* food to the diet, rather than its chemical content or quantity ingested, is taught by intelligent repetition.

All of these truisms are repeated at every meeting with the mother until, when the baby finally asserts himself in the first half of the second year, the mother meets the child's reaction with a kind of pre-solved expectancy, and no clash of personality or jurisdiction occurs. This takes much time on the part of the busy

physician, but it is more than worth the endless and repetitious lectures later when the problem has appeared. It may be less time consuming to write a prescription for a vitamin B complex, and toss off the problem of non-eating with the careless platitude, "If he doesn't eat, let him get hungry," but the mind of the mother has been scaled by then against this type of suggestion.

The human young, after having had their food selected for the first six months of life, can determine their own dietary needs as do the offspring of other invertebrate and vertebrate animals. This generalization was demonstrated by Dr. Clara Davis in her famous and oft-quoted experiment (42). Fifteen children from six to eleven months old, selected their own diets from a large and varied assortment of cooked and uncooked foods offered them three times a day for four and one half years. Not only was the calorie intake within the limits set by accepted scientific nutritional standards of the respective ages, but also was the self-selection of vitamin, mineral and fluid requirements spontaneously chosen adequate for these standards. On repeated x-ray observations, the bones were well within the normal limits. Hemoglobin and red cell values, and age-weight-height ratios all were maintained at optimum and often at superior levels.

Dr. Davis has shown unequivocally that human infants know their capacities for food, and should be given the opportunity to "balance their diets" when the foods offered them contained the accepted requirements. Many pediatricians have observed that much of the strife and anxiety of the parents stem from the fact that the child often refuses certain types of starch or protein foods, that certain vegetables or fruits are preferred, and that these choices may run counter to the lay concept of what constitutes a balanced and adequate food intake. However once the battle between parents and child is joined, the aversion for all foods, and the desire for negativistic argument are extended to all offerings at every meal—and the cyclic problem is in full sway.

It may be stated without exception that no physically well or mentally normal child will starve himself or suffer any clinical degree of malnutrition if the average American diet is offered to him sans a "sales talk" or implication of anxiety on the part of the parents. This axiom however, is most difficult for the modern

parent to accept and believe, and its violation is the basis for the omnipresent problem of anorexia in the American home today.

The reader is urged to review the interestingly written summary of the experiment by Dr. Davis, and the irrefutable conclusions as they apply to the art of food-taking in the home and hospital.

### Sequel

Unfortunately, many of the problems of later childhood are based on the failure to solve the non-eating habit, and more and more difficulties beset the harassed parent and her medical advisor. Here enters the child psychiatrist who sagaciously points out the evolution of the problem as stated above, but even he often fails to deflect the parental obsession. Many a learned discourse by the most formal of the child counsellors has ended in despair for both the parent and physician by that plaintive and final—“*but he won't eat!*”

Feeding problems are *formed*, not *born* in the child, and their prevention from the newborn period onward is one of the important precepts of every earnest physician interested in the long perspective of infant nutrition.

### MINIMAL VERSUS OPTIMAL CARE OF INFANTS

With the decline of the American infant mortality rate in the 2nd to 12th month period where infant care and feeding play a role, it is an irony that there should be noted a somewhat reprehensible maternal attitude which may be a modern trend. Two or three generations ago mothers and children attendants stood hopelessly by when even the best trained medical personnel of that day could do little to stem the spectre of death inherent in unclean milk supplies and other unhygienic factors beyond control (page 5). In contrast to the alleviation of these desperate anxieties, many modern mothers of any economic or cultural level, tend to pursue a philosophy that might be called “*minimal care with assurance of survival.*” They question, among other things, the necessity of sterilizing bottles and other feeding equipment as well as the hygienic precautions required of the milk mixture. They contend that “contaminated milk” and its results are from

the "old days," and imply that one never hears of unclean food or the bad results accruing from poor local hygiene. These *negativists* harass the physician with subtle inferences of over-doing sterilizing procedures, and constantly ask when these precautions might be discontinued.

After the recent publication by a pediatrician (64) as to the acceptance rate of unwarmed, refrigerator-temperature bottles of milk mixture, many special feature writers of "baby columns" in trade and daily papers seized upon this as a deviation, with the inference that it was a recommended procedure in the light of modern infant care (page 164). They estimated, for instance, the number of bottles a mother must warm (over 1400) and they calculated the time and BTU units which were "wasted." The physiological reasons for bringing food to body temperature (page 165) can easily be justified, but the widespread interest this item stimulated is still paramount in the questions and discussions which mothers have with their physicians on this point.

Other pressures brought upon the practitioner of infant care are: when may whole milk be prescribed instead of the formula mixture to eliminate the arduous (?) task of preparing the formula; when may weaning from the bottle be instituted; why can't the one-formula milks be prescribed in *liquid* form so that measuring and stirring can be eliminated; how early can the baby be "forced off" the night feeding; and when will he be ready for three meals a day? All of these constant hints and veiled suggestions are evidences of the subtle undermining of the major premise of infant culture, that of *maximum* or at least *optimum* baby care rather than some short route for the sake of questionable efficiency in the home.

These facts are here presented to the new physician as an illustration of the various influences he will be expected to challenge. Many sociologists and anthropologists interpret these signs as ominous portents for the infant and family culture of today. These pressures, if they are signs of decadence, can be neutralized by the physician in his contact with the ever-questioning parents. It is easy for the physician to substitute a scientific answer for a sharp remonstrance, and with patience he can negate the question which is not in keeping with modern pediatric thought. It is

amazing to observe the effect when it is pointed out that the early addition of solid food means *more* work rather than less, or that the early introduction of strained meat when it is not nutritionally needed is quite expensive, and then to observe that these simple suggestions will soon nullify pressure arguments. One is impressed with the thought that most mothers introduce these minor heresies because of a lack of accurate information or because of misinformation by their friends, and they wish to appear well-informed. Another corollary is that they merely want some ammunition to justify their own viewpoint with which to subdue their more aggressive relatives and friends. It can be skillfully and deftly done by a patient physician with minimum embarrassment to a mother, and it will usually result in a staunch supporter for his cause in the future.

#### “PR”

This symbol *PR* has become familiar in most phases of the American scene and its usual implication is *Public Relations*, in the improvement of which the medical profession has left much to be desired. This is witnessed in the evidence published by the pollsters that physicians in general are presently occupying the lowest rating ever in public approval. This chapter in this book is not the place to discuss the cause or remedy of this situation but there are minor applications which could be made in the field of infant feeding which could contribute some help to the general cause.

Another interpretation of the symbol in relation specifically to child care would be to have it interpreted as *Parent Relations*—between parents and the medical advisor to their children. In the average parent the solicitude for their young is a facet of their personality unlike any other characteristic they might expose. When an infant comes into the home this trait is newly awakened, it is tender, given to emotional overtones and is often fraught with anxiety. Into this unusual psychological state the physician is precipitated in his relationship with them and their infant. Much distrust and unwarranted suspicion can be ameliorated if the practitioner is aware of this bond, and if a few cardinal principles are remembered and practiced.



"Let's settle this here and now. Who is your pediatrician . . . me or Dr. Spock?"

Fig. 13. (Reprinted with the permission of the cartoonist Harold Sharp and of the J.A.M.A. where it appeared.)

In the modern or present era most parents have a higher level of formal education than had any generation of parents before them. In addition to this fact almost every daily paper, Sunday paper supplements and many trade magazines contain columns and feature articles on infant care. This makes the parents more conscious and more conversant, albeit not always accurately informed, with a speaking knowledge of child culture. All of these facts auger for a better understanding between practitioner and his parent listeners.

The source on which the parents are most informed and on which they lean heaviest is that of the writings of Dr. Benjamin Spock in his *Baby and Child Care*—a paper bound compendium which has sold into the millions of copies since its original printing of the first edition in 1946, and has become the baby care "Bible" in many homes of the present day. It would be well for any newly-trained physician to make this required reading, not only to embrace Dr. Spock's all-encompassing philosophy but also to be fore-armed as to the quotes to which he will be subject from parents, well-conversant with the Spockian doctrines. The accom-

panying cartoon is puckishly delightful in that it sets up the medic as the victim of his own arrogance. To question the Spock dicta and influence in any mothers' tenets is to court disaster and contra-wise, any elucidation of Spock's ideas can easily be woven into agreement with most any physician's beliefs.

Time spent in an exposé of small segments of the modern accepted truths of child culture, in an explanation of minor symptoms which plague the parents, in pointing out prognoses of some traits the baby indicates, or even in annotating many of the nutritional truths rampant in fable and fact—all are a kind of insurance for the future of the parent-physician relationship. The questions asked by parents are rarely motivated by criticism but rather from a desire to know the current truths which should justly be interpreted for them. When a mother plaintively (or aggressively) asks when her infant will have a certain solid food added to the fluid milk mixture, she is usually seeking information rather than voicing a censure; or she may be seeking a plausible argument to refute her neighbor whose own doctor is engaging in a kind of gastronomic race in adding "strained cucumbers" at the sixth week. A factual explanation as to the actual nutritional contributions and needs of the various solid food supplements at various levels of the first year will placate her and will vindicate her physician's viewpoint. Fierce loyalty is expressed by an understanding and well-handled mother in protection of her own infant's physician's opinion, and woe to the baiting sister-in-law or aggressive neighbor who dares engage her in debate!

Another tangent in amplifying the advice of the previous paragraph would be to call attention to a too-frequent attitude of the young practitioner. With his elaborate training in school and hospital the newcomer often assumes an "ivory tower" air—an assumption of the role of a dictatorial oracle who deigns to issue directives—and "let no dog bark!" Here are more sample questions which may act as an irritant or a challenge to the alert physician: "Why do you prefer (brand name of a pre-modified milk) over (another brand name)?" "Why do you not specify an evaporated milk by its brand name?" (when her mind has been conditioned to one specific brand). "Why do you add vegetables before you begin fruit (or vice-versa)?" "Why do you advise strained meat

later in the diet than the mailing list brochures advise?" "Why did my first baby require more sugar in the formula than this one is getting?" "Why does the baby have only one bowel movement a day when my mother-in-law says that three are best?" By such queries the physician is either exhausted or challenged. All of these varied questions are born of a curiosity which is homely and personal, rather than to doubt the practitioner's authority. Humility and deference seasoned heavily with patience will pay great dividends when a possible crisis later in the child's life may demand tacit and unquestioned obedience sans explanation of the doctor's opinion. The ground work of such trust and confidence is established early by patient instruction on the mother's own intellectual plane. To become popular with a group of parents and thus to establish a wide practice (if these are a young physician's aims) is not to fawn over their offspring but to be known as "the doctor who explains things." A physician's role is also that of an instructor—not just that of a prescriber of medicaments.

#### "THE INEVITABILITY OF GRADUALNESS"

By the sincere belief in and employment of this ponderous English axiom the British diplomats and politicians of the 19th century forged an empire upon which, was said, the sun never set. It also contains the essence of a principle which can be well-employed in medicine and infant feeding—the value in the *inexorableness of waiting* for Nature to help in the physician's well-meant and studiously-designed ventures.

Typical of the young practitioner is to become impatient with the results of his ministrations and to expect immediate and dramatic effects to follow his therapy and decisions. Physiological processes, even when well-understood, are often slow to become activated or to have results which are readily demonstrative. When dealing with the young, the physician has forever on his side the ally of development and growth in all of their dynamic impetus. Often only patience and a sincere recognition of these forces are required to achieve the desired end.

The fallacy of frequent formula changes before awaiting expected results discussed more fully elsewhere (page 78), well-illustrates the logic in the above-mentioned platitude. Many prac-

tioners anticipate changes to occur within 24 hours or less, and when they are not forthcoming another switch is made to some other milk mixture. Since there are 78 separate milk bases and 26 CHO additives, there are all of those possible combinations to employ. To have the knowledge of the principles of infant feeding in mind, and the fortitude to cling to his own beliefs will often extricate the physician from his misgivings. And yet the desire to "do something" is forcibly felt by the inexperienced and impatient. When Dr. Charles May was active in clinical teaching, he had a placard posted in view of his often over-zealous resident physicians, upon which was imprinted the reverse of a well-worn idiom—"DON'T JUST DO SOMETHING—STAND THERE!" (133). By this effective counsel many a "beaver" resident learned the golden reward of patiently awaiting the results of his decisions rather than rushing headlong into another mental cul-de-sac.

These truths have their counterparts of therapy, specifically toward children or in general medicine. It is axiomatic to an observing practitioner that many of the ills with which human beings are afflicted clear up without the beneficence of pharmaceutical preparations. *Vis medicatrix naturae* (the healing power of Nature) is the cornerstone on which Christian Science temples are built; it is the saving grace of the quacks, cults and faith healers. And yet medical schools wittingly, or otherwise, convey a different impression to the medical student and intern. For more than is justifiable in experience, the student is left with the impression, and shared by the laity, that a disease process demands a *cure* rather than a *recovery*; a something active from without (commonly from a bottle) rather than a restoration from within. The intern or young practitioner with as yet no adequate sense of relative values as results from practical experience, often try one drug or therapeutic measure after another, and many never get over it in their supposedly more mature days. Their therapeutic resourcefulness is to be envied if it were not based on the fallacy that all indispositions of man must have a specific treatment.

The rashness of the inexperienced can be somewhat condoned because of the enthusiasm of their innocence. The more veteran physician can only plead vanity, deceit or gullibility when he feels

constrained to believe that most ills to which human beings are heir must be absolved in some way by some item in the *materia medica*. Dr. Joseph Brennemann, a wise observer and keen clinician, stated it succinctly in his presidential address to the members of the American Pediatric Society: "The necessity of doing something is so deeply rooted in human psychology that it can never be quite ignored. . . . There is a therapeutic mellowness that comes with years of practical observation of the fallibility of so many once-cherished and authoritative procedures" (19).

All those who have the privilege of meeting the bright young men and women, in a teaching capacity, wish to help them bridge the crevasse of disappointment made up of the inefficacy of much of their therapeutics. *Gradualness*, in treatment or infant feeding, will *inevitably* reward those who patiently await its promises. Many diseases are self-limited and do not even need the slightest assist. "TIME is generally the best doctor." (*Ovid* 43 B.C.-A.D. 18.)

*In science, the credit goes to the man who convinces the world, not to the man to whom the idea first occurs.*

SIR WILLIAM OSLER

(Harvey Cushing: *The Life of Sir William Osler*, Vol. II, Chap. 28.)

# APPENDIX

## DATA USEFUL IN INFANT FEEDING

TABLE 38  
METRIC EQUIVALENTS

1 gram	equals 1 cubic centimeter (water)
30 grams	equals 1 ounce (weight)
30 cubic centimeters	equals 1 ounce (fluid)
1000 grams	equals 1 kilogram
454 grams	equals 1 pound
1 kilogram	equals 2.2 pounds
1000 cubic centimeters	equals 1 liter
946 cubic centimeters	equals 1 quart

TABLE 39  
HOUSEHOLD MEASURES AND EQUIVALENTS (approximate) (45)

One teaspoonful	4 cc.	60 min.	1 dr.	$\frac{1}{8}$ oz.	$\frac{1}{3}$ tablespoonful
One dessertspoonful	8 cc.	120 min.	2 dr.	$\frac{1}{4}$ oz.	$\frac{1}{2}$ tablespoonful
One tablespoonful	15 cc.	240 min.	4 dr.	$\frac{1}{2}$ oz.	3 teaspoonfuls
One cup	180 cc.	2,880 min.	18 dr.	6 oz.	12 tablespoonfuls
One glass	240 cc.	3,840 min.	64 dr.	8 oz.	16 tablespoonfuls

TABLE 40  
SOLUTION EQUIVALENTS (approximate) (45)

1% solution	1 gm. per 100 cc. or	4.5 grains per oz.
5% solution	5 gm. per 100 cc. or	22.5 grains per oz.
20% solution	20 gm. per 100 cc. or	90 grains (1.5 dr.) per oz.
50% solution	50 gm. per 100 cc. or	240 grains (4 dr.) per oz.
1/250 solution	0.4 gm. per 100 cc. or	2 grains per oz. or 60 grains per qt.
1/1000 solution	0.1 gm. per 100 cc. or	0.5 grains per oz. or 15 grains per qt.

TABLE 41

QUANTITIES FOR MAKING PERCENTAGE SOLUTIONS w/v (132)

Basis: 1 fl. oz. water at 25° C. = 454.57 gr. = 480 minims

Percentage Solutions w/v	Grains of Material Required to Make Aqueous Solutions							
	$\frac{1}{4}$ fl. oz.	$\frac{1}{2}$ fl. oz.	1 fl. oz.	2 fl. oz.	3 fl. oz.	4 fl. oz.	6 fl. oz.	8 fl. oz.
0.10 (1:1000)	$\frac{1}{9}$	$\frac{2}{9}$	$\frac{4}{9}$	$\frac{9}{10}$	$\frac{11}{3}$	$\frac{14}{5}$	$2\frac{11}{16}$	$3\frac{5}{8}$
0.20 (1:500)	$\frac{2}{9}$	$\frac{4}{9}$	$\frac{9}{10}$	$\frac{14}{5}$	$2\frac{11}{16}$	$3\frac{5}{8}$	$5\frac{1}{2}$	$7\frac{1}{4}$
0.25 (1:400)	$\frac{2}{7}$	$\frac{4}{7}$	$\frac{11}{5}$	$2\frac{1}{4}$	$3\frac{3}{8}$	$4\frac{1}{2}$	$6\frac{13}{16}$	$9\frac{1}{8}$
0.50 (1:200)	$\frac{4}{7}$	$1\frac{1}{8}$	$2\frac{1}{4}$	$4\frac{1}{2}$	$6\frac{13}{16}$	$9\frac{1}{8}$	$13\frac{5}{8}$	$18\frac{1}{8}$
1	$1\frac{1}{8}$	$2\frac{1}{4}$	$4\frac{1}{2}$	$9\frac{1}{8}$	$13\frac{5}{8}$	$18\frac{1}{4}$	$27\frac{1}{4}$	$36\frac{3}{8}$
2	$2\frac{1}{4}$	$4\frac{1}{2}$	$9\frac{1}{8}$	$18\frac{1}{4}$	$27\frac{1}{4}$	$36\frac{3}{8}$	$54\frac{1}{2}$	$72\frac{3}{4}$
3	$3\frac{1}{8}$	$6\frac{7}{8}$	$13\frac{5}{8}$	$27\frac{1}{4}$	41	$54\frac{1}{2}$	$81\frac{1}{8}$	$109\frac{1}{8}$
4	$4\frac{1}{2}$	$9\frac{1}{8}$	$18\frac{1}{4}$	$36\frac{3}{8}$	$54\frac{1}{2}$	$72\frac{3}{4}$	$109\frac{1}{8}$	$145\frac{1}{2}$
5	$5\frac{1}{4}$	$11\frac{3}{8}$	$22\frac{3}{4}$	$45\frac{1}{2}$	$68\frac{1}{8}$	$90\frac{7}{8}$	$136\frac{3}{8}$	$181\frac{13}{16}$
10	11 $\frac{1}{8}$	$22\frac{3}{4}$	$45\frac{1}{2}$	90	$136\frac{3}{8}$	$181\frac{13}{16}$	$272\frac{3}{4}$	$363\frac{5}{8}$
15	$17\frac{1}{16}$	$34\frac{1}{8}$	$68\frac{1}{8}$	$136\frac{3}{8}$	$204\frac{1}{2}$	$272\frac{3}{4}$	$409\frac{1}{8}$	$545\frac{1}{2}$
20	$22\frac{3}{4}$	$45\frac{1}{2}$	$90\frac{7}{8}$	$181\frac{7}{8}$	$272\frac{3}{4}$	$363\frac{5}{8}$	$545\frac{1}{2}$	$727\frac{3}{8}$
25	$28\frac{3}{8}$	$56\frac{7}{8}$	$113\frac{5}{8}$	$227\frac{1}{4}$	$340\frac{7}{8}$	$454\frac{1}{2}$	$681\frac{1}{8}$	$909\frac{1}{8}$
40	$45\frac{3}{4}$	$90\frac{3}{4}$	$181\frac{7}{8}$	$363\frac{5}{8}$	$545\frac{1}{2}$	$727\frac{3}{8}$	1091	$1454\frac{5}{8}$

Percentage concentrations of solutions are generally expressed as follows, according to the *United States Pharmacopoeia XVI*:

Per cent “weight in weight” (w/w) expresses the number of grams of an active constituent in 100 grams of solution.

Per cent “weight in volume” (w/v) expresses the number of grams of an active constituent in 100 milliliters of solution.

Per cent “volume in volume” (v/v) expresses the number of milliliters of an active constituent in 100 milliliters of solution.

When “per cent” is given in prescriptions without qualification, then it means one of the following:

For solutions of solids in liquids, per cent means weight in volume (w/v).

For solutions of liquids in liquids, per cent means volume in volume (v/v).

For solutions of gases in liquids, per cent means weight in volume (w/v).

For example, a 1% solution is prepared by dissolving 1 gram of a solid or 1 milliliter of a liquid in sufficient quantity of the solvent to make 100 ml. of solution.

TABLE 42

CALORIC MEASURE OF MAIN FOOD COMPONENTS

1 gram of carbohydrate yields 4 calories
1 gram of protein yields 4 calories
1 gram of fat yields 9 calories

TABLE 43  
WEIGHT

1. Seven lbs. at birth—boys more.
2. Premature infant may be defined as one whose weight *at birth* is 2500 grams (5 lbs., 8 oz.) or less. (There are other definitions acceptable)
3. Initial weight loss—about 1/10 of birth weight in first 4 days.
4. Loss regained in 10 to 14 days.
5. Average gain—5 to 7 oz. per week, first 3 months; 3 to 5 oz. per week, 3 to 6 months; 4 oz. per week until 1 year. Birth weight doubled at 5 months; trebled at 1 year.
6. Easy "*rule of thumb*" to remember first year weights: 1 month, 8 lbs.; 2 months, 10 lbs.; 3 months, 12 lbs. From 4th to 10th month, weight is about that of last digit—4 months, 14 lbs.; 5 months, 15 lbs.; etc. to 9 months, 19 lbs. As activity begins, gain falls off—1 year, 20 to 22 lbs.
7. These estimations are merely average rules and do not apply to infants much over or under average birth weight.

TABLE 44  
LENGTH

1. Twenty and one-half inches at birth—boys taller.
2. Twenty-eight to 30 inches at 1 year—boys taller.
3. Twice length at 2 years is approximate mature height.
4. Racial and familial traits are strongly expressed in height increments, even in infancy.

TABLE 45  
SLEEP

1. Seventeen to 21 hours per day in first 2 to 3 months.
2. Twelve to 16 hours per day at one year.
3. Open to wide variation depending on "*tone*" of nervous system (hypertonic, hypotonic); (endomorphie, mesomorphie, ectomorphie types—SHELDON).

TABLE 46  
AVERAGE DENTITION

Deciduous, "Milk Teeth," "Baby Teeth"—Total 20	Average Time of Eruption in Months
Two lower central incisors . . . . .	5-8
Two upper central incisors . . . . .	8-12
Two upper lateral incisors . . . . .	10-12
Two lower lateral incisors . . . . .	12-15
Four anterior molars . . . . .	14-18
Four canines (cuspids) . . . . .	18-24
Uppers—"eye teeth"	
Lowers—"stomach teeth"	
Four posterior or second molars . . . . .	24-36
("two-year molars")	

At one year—6 teeth; 18 months—12 teeth; 2 years—16 teeth; 3 years—20 teeth.  
Sequence and time of appearance is subject to wide normal variation, and delayed dentition is no index of a deficiency of mineral metabolism. Lay parents wrongly emphasize the importance of the appearance and speed of tooth eruption as a criterion of normal growth and development. This has no clinical corroboration, unless drastically delayed.

TABLE 47  
A PRACTICAL DEVELOPMENTAL SCALE FOR THE FIRST YEAR  
(Abstracted from Aldrich and Norval (4))

Evident Steps in Neuromuscular Growth	Average Month
1. SMILE—response to social stimuli . . . . .	0.9
2. VOCAL—utters sounds as "ah," "eh," "uh," spontaneously or on stimulation . . . . .	1.7
3. HEAD CONTROL—head does not lag when lifted by hands from supine to sitting position . . . . .	2.9
4. HAND CONTROL—grasp or close on toy with one or both hands when toy is dangled above chest . . . . .	4
5. ROLL—back to abdomen spontaneously . . . . .	5.1
6. SIT—sits alone for several moments . . . . .	6.2
7. CRAWL—any individual modification of progress . . . . .	7.3
8. PREHENSION—bringing together thumb and index finger to pick up an object . . . . .	8.1
9. PULL-UP—pulls self up to standing position . . . . .	8.7
10. WALK WITH SUPPORT—walks by holding to furniture or adult . . . . .	9.5
11. STAND ALONE—stands with support for several moments . . . . .	10.7
12. WALK ALONE—takes several steps alone . . . . .	12

Author's comment: *These averages compare well with the levels of development described by Chaille', Bühler, McGraw, Bayley, Gesell, Morgan, Shiun and Amatruda, except for #12—walking alone. This achievement listed by the other authors fell between the 14th and 16th months—later than in the Aldrich-Norval series. The reader is reminded that each child has his own rate of growth which reflects his own individuality and maturity, and that the appearance of these abilities may be modified by the effects of environment.*

The data presented in Table 47 is here shown in the original form from Aldrich and Norval. Because parents are constantly interested in the "normal" development of the infant, this graph can conveniently be made up into a rubber stamp and imprinted on the clinical record of each infant, as can an immunization record, as intrinsic parts of the individual charts. The average or norm *curve* is left off of this suggested rubber stamp because it requires much explanation if the infant falls below the established curve. For this reason the curve may be completed at the end of the first year and the average or norm then superimposed upon the chart, showing in graphic form the variation of the specific infant above and below a so-called normal curve. It is a striking way to demonstrate the status of any infant after a year and which any parent will easily understand.

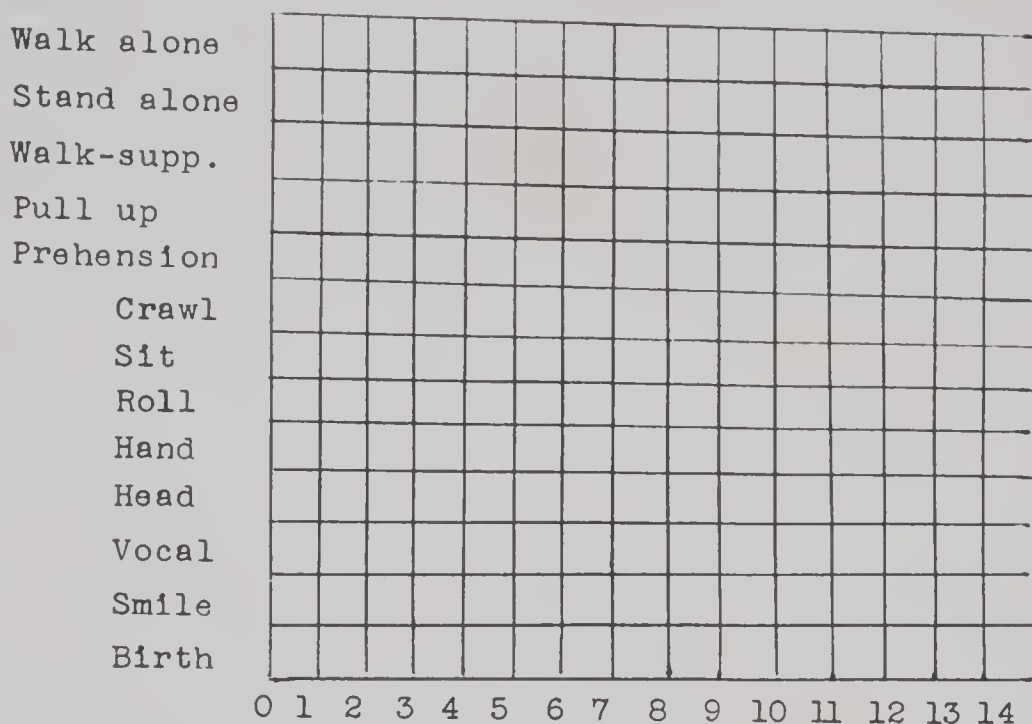


FIG. 14. Developmental Scale in Graph Form (4) (Suggested to be made up (*actual size*) into a rubber stamp and used on individual patient office records).

TABLE 48

NORMAL BLOOD LEVEL VALUES OF SPECIFIC NUTRIENTS AND OF  
OTHER BLOOD CHEMISTRY IN CHILDREN

(per 100 cc. of blood)

Vitamin A—	100–250 I.U.	Sodium—	317 mg.
Carotene—	100–300 I.U.	Cholesterol—	50–100 mg.
Vitamin C—	0.6 mg.	Creatinine—	1–2.5 mg.
Calcium—	10.5–12 mg.	Glucose—	70–110 mg.
Phosphorus—	4.5–6.5 mg.	Non-protein Nitrogen—	25–40 mg.
Iron—	under 1 mg.	Total Plasma Protein—	5.46–6.9 gm.
(non-hemoglobin)		Albumin Plasma Protein—	4.08–4.92 gm.
Chlorides—	580–630 mg.	Globulin Plasma Protein—	1.28–1.98 gm.
Copper—	1.0 mg.	Albumin-Globulin Ratio—	50/40–75/25
Magnesium—	5.0 mg.	Urea—	10–23 mg.
Potassium—	20 mg.	Uric Acid—	2.5–5
		CO <sub>2</sub> capacity—	50–60 vol. %

TABLE 49

RELATIVE COSTS OF VARIOUS INFANT FORMULA MIXTURES  
(Based on a one-day, 30 oz. total unit mixture of 5 six-oz. feedings)

Ingredients of Formula	Cost of Retail Unit	Cost per Oz.	Amount Required	Total Cost per Day
1. Evaporated Milk Karo-Corn Syrup	13 oz. can 12½¢ 1 pt. (16 oz.) 26¢	1¢ 1.6¢	10 oz. 1½ oz. (2 T)	\$0.10 .02¼ — .12½
2. Whole Past. Milk Granulated Sugar	1 qt. (32 oz.) 21¢ 1 lb. (16 oz.) 10¢	0.65¢ 5¢	20 oz. 1½ oz. (2 T)	\$0.13 .01 — .14
3. Whole Past. Milk Dextri-Maltose®	1 qt. (32 oz.) 21¢ 1 lb. (16 oz.) 98¢	0.65¢ 6.1¢	20 oz. 1½ oz. (4 T)	\$0.13 .09 — .22
4. Evaporated Milk Dexin®	13 oz. can 12½¢ 12 oz. can \$1.00	1¢ 8.3¢	10 oz. 1½ oz. (6 T)	\$0.10 .13 — .23
5. Lactic Acid Milk with Dextri-Maltose®	1 lb. (16 oz.) \$1.79	7.3¢	4⅔ oz. (15 T)	\$0.31
6. Pre-modified Mixture Lactum® (liquid)	13 oz. can 27¢	2¢	15 oz.	\$0.30
7. Pre-modified Mixture Similac® (dry)	1 lb. (16 oz.) 99¢	6.1¢	4 oz. (16 T)	\$0.25½
8. Protein Milk with added Dextri-Maltose®	1 lb. (16 oz.) \$2.29 1 lb. (16 oz.) 98¢	13¢ 6.1¢	4 oz. (15 T) 1½ oz. (4 T)	\$0.52 .09 — .61
9. Sobee® (dry) Dextri-Maltose®	1 lb. (16 oz.) \$1.39 1 lb. (16 oz.) 98¢	8.6¢ 6.1¢	4 oz. (24 T) 1½ oz. (4 T)	\$0.35½ .09 — .44½
10. Mullsoy® (liquid) Beta-Lactose®	15½ oz. can 45¢ 1 lb. (16 oz.) \$1.25	2.9¢ 7.8¢	15 oz. 1½ oz. (6T)	\$0.45 .12 — .57
11. Meyenberg® Evap. Goats' Milk Dextri-Maltose®	14 oz. can 53¢ 1 lb. (16 oz.) 98¢	3.8¢ 6.1¢	10 oz. 1½ oz. (4 T)	\$0.38 .09 — .47

(Continued on next page)

(The prices quoted here are as of June 1, 1959 and the sources for the information are the same as mentioned for Table 51.)

It is to be emphasized that the above combinations are arbitrarily chosen; any other combination would be equally satisfactory digestion-wise and might yield a lower cost.

TABLE 49—(Continued)

Ingredients of Formula	Cost of Retail Unit	Cost per Oz.	Amount Required	Total Cost per Day
12. Dale Dehydrated Goats' Milk <sup>®</sup> Karo Syrup	1 lb. (16 oz.) \$2.17 1 pt. (16 oz.) 26¢	13.5¢ 1.6¢	3 $\frac{3}{4}$ oz. 1 $\frac{1}{2}$ oz. (2 T)	\$0.50 $\frac{1}{2}$ .02 $\frac{1}{2}$ — .53
13. Fresh Goats' Milk Granulated Sugar	1 qt. (32 oz.) 73¢ 1 lb. (16 oz.) 10¢	2.2¢ $\frac{5}{8}$ ¢	20 oz. 1 $\frac{1}{2}$ oz. (2 T)	\$0.44 .01 — .45
14. Enzylac <sup>®</sup> Milk Dextri-Maltose <sup>®</sup>	1 qt. (32 oz.) 34 $\frac{1}{2}$ ¢ 1 lb. (16 oz.) 98¢	1¢ 6.1¢	20 oz. 1 $\frac{1}{2}$ oz. (4 T)	\$0.21 .09 — .30
15. Soft Curd <sup>®</sup> Milk Cartose <sup>®</sup>	1 qt. (32 oz.) 34 $\frac{1}{2}$ ¢ 1 pt. (16 oz.) 59¢	1¢ 3.8¢	20 oz. 1 $\frac{1}{2}$ oz. (2 T)	\$0.21 .05 $\frac{7}{10}$ — .26 $\frac{7}{10}$
17. Certified <sup>®</sup> Milk Sweetose <sup>®</sup> Syrup	1 qt. (32 oz.) 36 $\frac{1}{2}$ ¢ 1 pt. (16 oz.) 26¢	1.1¢ 1.6¢	20 oz. 1 $\frac{1}{2}$ oz. (2 T)	\$0.22 .02 $\frac{4}{10}$ — .24 $\frac{4}{10}$
18. Varamel (Milk) Karo <sup>®</sup> Syrup	13 oz. can 19¢ 1 pt. (16 oz.) 26¢	1.4¢ 1.6¢	13 oz. 1 $\frac{1}{2}$ oz. (2 T)	\$0.19 0.2 $\frac{4}{10}$ — .21 $\frac{4}{10}$
19. Dryco <sup>®</sup> (dry) Instant Lactose	1 lb. (16 oz.) \$1.19 1 lb. (16 oz.) \$1.00	7.4¢ 6.1¢	4 oz. 1 $\frac{1}{2}$ oz. (5 $\frac{1}{2}$ T)	\$0.29 $\frac{6}{10}$ .09 — .38 $\frac{6}{10}$

TABLE 50

COMPARATIVE PRICES OF SOME CARBOHYDRATE MODIFIERS AND ADDITIVES

Carbohydrate	Price per Retail Unit	Price per Oz.	Tablsp. per Oz.
Beta-Lactose <sup>®</sup> (D)	\$1.25 (lb.)	7.8¢	3
Cartose <sup>®</sup> (L)	59¢ (pt.)	3.8¢	2
Dexin <sup>®</sup> (D)	\$1.00 (lb.)	8.3¢	6
Dextri-Maltose <sup>®</sup> (D)	98¢ (lb.)	6.1¢	4
(#1, #2, #3)			
Hidex <sup>®</sup> (D)	85¢ (lb.)	5.3¢	4
Honey (L)	33¢ (lb.)	2¢	2
Lactose (Merck) (D)	\$1.49 (lb.)	9.3¢	3 $\frac{2}{3}$
Lactose (Instant) (D)	approx. \$1.00 (lb.)	8.3¢	5 $\frac{1}{2}$
Kanana <sup>®</sup> Banana Flakes (D)	69¢ (5 $\frac{1}{2}$ oz.)	12.5¢	4
Karo <sup>®</sup> Syrup (L)	26¢ (pt.)	1.6¢	2
Malt Soup Extract (L)	\$2.89 (pt.)	18¢	2
Malt Soup Extract (D)	\$2.99 (lb.)	18¢	4
Sweetose <sup>®</sup> Syrup (L)	26¢ (pt.)	1.6¢	2
Sugar (Cane or Beet) (D)	10¢ (lb.)	0.6¢	2

(The prices are as of June 1, 1959 and the sources for this information are as mentioned under Table 51.)

TABLE 51  
COMPARATIVE PRICES OF SOME BOTTLE-FED FORMULA FOODS

Bottled Milks	Price of Retail Unit	Price Per Oz.	Tabls. per Oz. (Dry)
Whole Vit. D Milk	21¢ per qt.	0.65¢	—
Skimmed Milk	20¢ per qt.	0.6¢	—
Butter Milk	21¢ per qt.	0.6¢	—
Enzylac® Milk	34½¢ per qt.	1.06¢	—
Enzylac® Skimmed Milk	31¢ per qt.	0.9¢	—
Goats' Milk	73¢ per qt.	2.2¢	—
Soft Curd® Milk	34¢ per qt.	1.06¢	—
Certified® Milk	36½¢ per qt.	1.1¢	—
LO-Sodium® Milk	53½¢ per qt.	1.6¢	—
HI-PROtein Milk	20½¢ per qt.	0.6¢	—
<i>One-Formula Milks</i> (Liquid—13 oz. can; Dry—1 lb. can)			
Baker's Liquid	25¢	1.5¢	—
Baker's Dry	99¢	6.1¢	3
Bremil® (L)	29¢	2.2¢	—
Bremil® (D)	\$1.09	6.8¢	3½
Carnalac (L)	27¢	2¢	—
Hi-PRO® (D)	\$1.53	9.5¢	3
Lactum® (L)	27¢	2¢	—
Lactum® (D)	\$1.09	6.8¢	3½
Olac® (L)	27¢	2¢	—
Olac® (D)	\$1.09	6.8¢	3½
Similac® (L)	27¢	2¢	—
Similac® (D)	99¢	6.1¢	4
SMA® (L)	27¢	2¢	—
SMA® (D)	\$1.08	6.7¢	4
Dale® Dehydrated Goats' Milk (D)	\$2.17 (lb.)	3.5¢	3
Gerber's Concentrated Meat Base Formula® (L)	59¢ (13 oz.)	4.5¢	2
Hypo-Allergic® (D)	\$1.54 (lb.)	9.6¢	4
Meyenberg® Evaporated Goats' Milk (L)	53¢	4¢	—
<i>Miscellaneous Products</i>			
Dryco® (D)	\$1.19 (lb.)	7.4¢	3¾
Ketonil® (D)	\$22.50 (lb.)	\$1.40	4½
Klim® (D)	\$1.15 (lb.)	7.2¢	3½
Lactic Acid Milk with Dextri-Maltose® (D)	\$1.79 (lb.)	11.2¢	3½
Lofenlac® (D)	\$12.50 (2½ lb.)	56.2¢	3½
Protein Milk® (D)	\$2.29 (lb.)	14.3¢	3½
Varamel (L)	19¢	1.4¢	—

(Prices as of June 1, 1959. Prices of Bottled Liquid Milks from Medical Dairy Specialties, Chicago, and from local retail Chicago dairies; other products from Fair Trade retail prices found in *The Red Book*, 1959 Edition, The Topics Publishing Co., New York City, and supplied to author by J. F. Lacey, R.Ph. and W. T. Lacey R.Ph., Backus Pharmacy, Chicago.)

## DETAILED DATA ON SOLID FOOD SUPPLEMENTS FOR INFANTS

### Fortified Pre-cooked Cereals

The manufacture for infants of fortified cereal preparations has made available many of the essential mineral and vitamin requirements which are absent in a sole milk diet. (See Chapter 8 for identification and nutritional explanation of each of these foods.) These cereals have replaced to a large extent the former cereal food additives of whole grain cereals, like oatmeal. Other "standard bearers" like *Cream of Wheat*, *Ralston's Wheatena*, *Farina*, and *oatmeal preparations* which formerly were the first food addi-

AVERAGE NUTRITIVE VALUES OF FORTIFIED, PRE-COOKED CEREALS (per ounce)

Calories—100-130	Calcium— 150-300 mg.
Protein— 3-5 gms.	Phosphorus— 100-250 mg.
Fat—0.5-2.5 gms.	Thiamine— 0.4-0.6 mg.
CHO— 20-30 gms.	Riboflavin—0.03-0.20 mg.
Iron— 10-20 mg.	Niacin— 3-8 mg.

tions would be eclipsed at present in their uses if it were not for the fact that the enterprising manufacturers of these respective starch preparations have added minerals, vitamins and other essentials, and also have products which are "instant" preparations to compete with the fortified cereals mentioned above. The advantage of all of this pre-cooked state, needing only water or milk as a diluent is not the only labor-saving which they provide. The constancy of the end product with the retention of some of the heat labile substances, plus the elimination of the vagaries of home culinary skills, are the best reasons for their use. Because of their introduction to the infant diet at about 10 pounds of weight (second to third month), the requirements of thiamine, iron, additional calcium, and phosphorus are more than provided.

Many commercial products have been made available since Tisdall, *et al.*, in 1930, (172) and Brown and Tisdall in 1933 (20), designed the first fortified cereal mixture which was the original MEAD'S CEREAL. All of the preparations contain varying, but more than the minimum, requirement of the vitamins of the B complex and essential minerals. Most of them contain variations of the

basic grain cereal used: either one grain or poly-grain wheat, barley, oatmeal, corn meal, rice; dried brewer's yeast; non-fat milk solids; wheat germ; bone meal and alfalfa; reduced iron; dicalcium phosphate calcium carbonate; sugar; and salt.

**Strained and Unstrained** ("cubed," "diced," "Junior," etc.) **Vegetables and Fruits:** The canned food industry preparing vegetables and fruits for infants and children has gained by rapid strides since its innovation about 1928. Many of the members of the vegetable and fruit canning industry have found in the infant trade a tremendous outlet for their products. These may be said to be more effective when used for infants than the home-cooked product. There is constancy in the product, it is more finely strained, the end product is more uniform in mineral and vitamin content, and its pre-cooked state assures the consumer the constancy of the mineral and vitamin content without the over-cooking deterioration which may obtain in the domestic preparation. All of the vegetable and vegetable-starch-meat combinations, fruit and fruit-starch and fruit-pudding combinations, as well as the pudding preparations, are additional sources of calcium, iron, thiamine, riboflavin, niacin, vitamin A and other specific nutrients in appreciable amounts available for utilization. (See amounts on each product, or literature of the manufacturer.) The availability and inexpensiveness, to say nothing of the convenience, are secondary factors, but noteworthy of comment in urban areas especially.

A listing of all the kinds and combinations of vegetables, fruits, and puddings available for infant consumption would be impractical since most all are acceptable as solid supplements for infant use. The claims of the manufacturers are checked by the COUNCIL ON FOODS OF THE AMERICAN MEDICAL ASSOCIATION, and accepted or rejected by them. Such listings can be found in the single AMA reports, and published lists of accepted foods, available on request.

**Strained and Unstrained** ("chopped," "diced") **Meat Preparations:** As discussed previously, the addition of protein early in the infant solid supplement as well as in the milk diet has received much attention of late. These commercial products made available recently by the canned food industry have given the

idea of early protein additions much impetus. Scraped and finely chopped or home-strained meats are expensive, laborious to prepare, and not constantly or conveniently available. Since protein preparations carry with them the constant hazard of putrefactive and "*ptomaine*" changes when not adequately refrigerated, the access to the sterile and uncontaminated product has tremendous sanitary advantages, and adds much to the security of the prescribing of these protein food sources for the infant (16 gm. of complete protein to each 3½ oz. (100 gm.) can). The economy of these preparations is also an asset since it takes 6 oz. of beef to yield 3½ oz. cooked, scraped beef at home; 10 oz. veal round steak to produce 3½ oz. cooked veal; and, 6 oz. beef liver to make 3½ oz. ground liver.

An interesting observation as to how extensive the baby food industry has an appeal and sale's potential is the entrance into the field by a company with *Kosher* meats for infants. In the intimate contact with the Jewish patients of the author's practice which doctor-patient relationship brings, there has never been the impression that the young parents of that faith were "orthodox" in their differentiation of sources of appropriate food for their children. This apparently is not the case. Beef, veal, lamb, beef heart and liver in "strained" and "chopped junior" meats are available in independent and chain grocery stores with a wide distribution. These are promoted as "strictly Kosher" baby meats and apparently are reliable from the traditional requirements of Hebrew protocol, as they are in the secular nutritional content.

**Strained Fish Preparations:** In Chapter 8 mention is made of the excellent source of protein [high in amino acids] in fish as an infant food. It is also well recommended because of the specific nutrients and essential elements, especially *phosphorus*, *iodine*, *fluorine* and *Animal Protein Factor B<sub>12</sub>*. The availability of clean and unspoiled sources of fish in appropriately small amounts for infant consumption without the foreign-body hazard of bones is worthy of special comment. This product is usually strained tuna and this same species of fish is used in other food products in the infant line in combination with starch foods. All are nutritionally appropriate foods for infants and are usually well-accepted by the baby.

### Egg Yolks—Canned

There are several commercial preparations of egg yolk on the market either singly as egg yolk or in combination with meat preparations. One can contains  $3\frac{1}{4}$  egg yolks, and 2 tabs. equal 1 egg yolk. It is a convenient manner in which to provide egg yolk and there are no egg whites to discard or waste. The egg preparation is usually offered the infant by inclusion in the cereal food or might be given separately.

### Puddings

The manufacturers of solid foods for infants have included various kinds of puddings in their lines of products. They are essentially starch preparations with or without egg yolk and flavored with vanilla, chocolate and artificial fruit flavors, and have for their bases standard starches of corn and tapioca. Gelatine puddings are high in protein, and rennet puddings [which is merely the enzyme *rennet* added to whole milk producing a coagulated and of course pre-digested milk] are variously flavored with standard fruit and other flavors. These puddings provide a variation of education to the infant palate in texture and prevent a monotony of the ways in which egg and starch are added to the diet.

### Comment

In the earlier antecedent of this book an attempt was made to list the various solid food additives and their manufacturers. Since the industry has grown so enormously, and since there are very many products of each manufacturer, it would be difficult and pointless to merely enumerate all of the products for viewing when many are discontinued and others added at any time. All of these products meet the most critical nutritional standards and are by far better and more economical than any similar home-prepared product. Competition will keep the products nutritionally adequate and hygienically safe as it does in the bottle-fed foods. This is one advantage in a half-billion dollar annual market, offsetting the minor problems of choosing between the multitudinous products available.

### NATURAL FRUIT SOURCES OF VITAMIN C

With the advent of the frozen and concentrate orange juice industry, being established at the site of the orange groves, the cost, flavor, and vitamin C content of this product have been greatly changed. These products not only have a more constant vitamin C level than fresh orange juice at different times of the year, but the stability of the vitamin C is higher—the vitamin C level remaining constant for as long as 96 hours after reconstitution from the frozen state. Fresh oranges averaged 42 mg. of ascorbic acid per 100 cc. while the reconstituted concentrate averaged 45.5 gm. per 100 cc. for the same season of 7 months in 1947-48 (143). At times, fresh oranges purchased on the open market in Chicago had ascorbic acid values as low as 14.5 mg. per 100 cc.

In addition to the fresh and frozen sources of ascorbic acid containing fruit juices, there are juices prepared for infants which are fortified with high-levels of ascorbic acid. There are at least six manufacturers of some 22 or more products. They are unsweetened, sterile and inexpensive besides being convenient to use. All are acceptable scientifically if they are personally accepted by the baby consumer. The general opinion exists that infants have no taste discrimination except for texture, and a field of research is open to prove or to disprove this assumption. Why an infant will accept with pleasure one juice flavor and reject vehemently another with no background of experience and with no consistency is always an enigma. Since there are so many of the juices available this is rarely a problem. Most infants receive their daily requirement of vitamin C (30 mg.) in their supplemental vitamin administration, the additional source of ascorbic acid is therefore not essential. Education of the palate to varied flavors and sensations and a vicarious way of maintaining a water balance would be advantageous. These products are easily dispensed with if any allergic reaction should be noted, without fear of a nutritional deficit.

### SCHEMA FOR PRINTED DIET FORMS

As stated in Chapter 8, a printed diet list is a convenient and efficient form of instruction if it is not made too general and all-

inclusive. Adequate space should be left for specific, written-in instructions for the individual patient. These forms should be personally composed by each physician—the standard forms often supplied by commercial food companies invariably contain advertising of the donor and do not necessarily represent the original ideas of the prescribing physician.

Each list should contain the name, address, office hours, and telephone numbers of the physician—presented in an unobtrusive and dignified style, with no attempt in the format of garish type or graphic bids toward ostentation. The varied slips may be printed on different-colored paper for ease of identification, and all should be of the same size. Numbering lists as to the age of the infant is discouraged. In addition to the data referring to the food materials in the forms, they may also contain simply stated instructions, as well as platitudes regarding food attitudes which every physician soon incorporates into his philosophy. These personal maxims may appear repeatedly on various forms—repetition being the keystone of instruction. On successive lists, following the approximate age of four months, repeated emphasis may be made as to the specific immunizations which all infants should have administered.

All of these ideas are presented here from examining many forms which various successful physicians have designed. No effort is made to be specific in the composition or editing of these lists—only a general idea is given which is purely suggestive. The skeleton forms are here presented to be amplified by each physician, dependent on his own needs and ideas.

### **I. Newborn Infant Form (birth to about 10 pounds).**

This list is an important one, since it may introduce the doctor and systematic infant care for the first time to the parents of a new baby, and the list is often regarded by them as a symbol of the ideas which he represents. It is also important because confusion and indecision are rife in the mind of the new mother, and the printed word seems to be a guidon in this period of indecision and insecurity.

The NEWBORN INFANT FORM should contain about the following

data, with elaboration or modification as the individual physician sees fit:

1. Space for breast feeding technic.
2. Space for formula content and its preparation.
3. Instructions as to technic of giving a bottle, with the hazards of air swallowing and its prevention (see Chapter 7).
4. Instructions as to water administration.
5. Care of cord or navel.
6. Care of circumcision (if indicated).
7. Directions for keeping mental or written records of food taken, character of bowel movements and weight gain.
8. List of articles useful for infant care, as bottles, nipples, sterilizer, antiseptics, etc.
9. Bath instructions (optional).
10. Clothing instructions (optional).
11. Various directives as to maternal attitudes, forcing food, origin of feeding problems in infancy, and any individual ideas the physician wishes to impart to the new mother.
12. Instructions for vitamin addition (optional).

**II. Form for Infant 10 Pounds to About 17 Pounds** (approximately two to six months).

1. Space for breast or formula instructions.
2. Addition of cereal by spoon as first solid food. (List of kinds and preparation.)
3. Addition of vegetables (instructions as to preparation—list of kinds).
4. Addition of fruits (instructions as to preparation—list of kinds).
5. Addition of egg yolk with instruction as to administration.
6. Instructions for orange juice or synthetic vitamin C.
7. Instructions for vitamin D addition.
8. Approximate time for four-feeding per day routine if indicated by the baby.

**III. Form for Infant 17 Pounds to About 20 Pounds** (approximately 6 to 10 months).

1. Space for breast or formula instructions.
2. Addition of puddings (list of kinds).

3. Addition of starchy foods (potato, rice, banana, etc.). (List of kinds.)
4. Addition of chewing foods (dry breads, crackers, etc.). (List of kinds.)
5. Addition of whole egg and meat (the latter may be introduced much earlier).
6. Vitamin C and D instructions (other fruit juices substituted as source of vitamin C).
7. Approximate time for whole milk and three-meal routine if indicated by the baby.
8. Effort made to introduce unstrained vegetables, fruits, etc.

#### IV. General Form for Period After 20 Pounds (from first year on).

Most parents require a diet list for babies after the first year to stabilize their own attitudes and give them a directive as to what the infant child should and should not eat. About this time the child should be eating from the family board and the average American diet would be satisfactory. There are some foods which contribute nothing to the child's needs and these should be enumerated. It is also wise to list or emphasize the foods which are essential to the infant's growing demands and this can be done best by outlining a day's requirements in terms of meals, with wide latitudes mentioned as to *kinds* of essential foods. Some physicians find it desirable to sketch a menu for those parents who lack the ability to accept general directions. The latter suggestion is not to be enlarged upon or emphasized, since parents tend to become too literal when a definite menu is prescribed.

#### General Suggestions and Possible Meal Menus

##### BREAKFAST

Cereal—precooked, home-cooked, or dry.

Egg—soft, poached, or scrambled.

Fruit juice or fruit—baked, stewed, or raw.

Milk or cocoa—four to eight ounces.

##### DINNER

Meat or fish—strained, diced, or home-prepared (at least once daily).

Vegetables—one leafy or stem vegetable in addition to others, or vegetable soup.

Starches—potato, macaroni, spaghetti, noodles, rice, or bread.

Dessert—stewed fruits, puddings, or ice cream.

Milk, chocolate milk or cocoa, four to eight ounces.

#### SUPPER

Starches—as listed with gravy or creamed, bread or toast and milk, bread and gravy, cereal, or creamed soups (if not offered twice before—more than two starch foods per day, including cereal, is too much CHO).

Egg—instead of, or in addition to, that offered at breakfast.

Cheese—cottage, cream, Swiss, American, or any processed cheese (in hand to chew).

Bread—with oleomargarine or butter, with jelly, honey, or peanut butter.

Desserts—as listed above.

Milk, chocolate milk or cocoa.

#### FOODS TO AVOID (*It is wise to list this category on the menu.*)

Tea and coffee.

Pickles, spices, olives, or any highly seasoned foods.

All nuts and popcorn.

Sausage and seasoned cold cuts.

Beer, wine, and alcoholic beverages.

Cherries, plums, cantaloupe, and watermelon.

Corn, radishes, cucumbers, raw cabbage, and raw onion.

(The question as to whether the large meal (dinner) should be given at noon or the evening is a disputed one and can be advised best as an individual matter. "To go to sleep on a full stomach" is the platitude which is quoted to refute giving the dinner in the evening. To digest a meal while asleep is entirely physiological and should not be a deterrent. An advantage is that the young child also eats the general family food with the family, and this is an important psychological attitude rather than special food to be eaten alone. The only argument for eating the larger or main meal at noon is that less distractions are present at this time, and there are likely to be fewer adults about who are prone to give

the child too much attention and suggestions as to his eating habits.)

**General Remarks Regarding Diet Slips.** It is to be emphasized again that the lists presented here are merely suggestions for those who wish to utilize this direct method of giving instructions. Again the warning is repeated that when the directives are too definite, literalism on the part of the parent in interpreting the lists leads to ritualistic and dictatorial attitudes by the parents, which are the basic causes of faulty eating habits and behavior problems (see Chapter 10). This may be obviated in part by the appearance of warning "*punch lines*" on each diet slip, and many repetitious remarks on the part of the physician from the first visit through the second year, concerning food attitudes, demonstrations as to forcing food, and a general warning against strict interpretations of the printed form.

The various diet slips, of course, do not indicate that all of the food "additions" are made at one time. One printed form may suffice for several consultations with the irrelevant additions crossed off or others substituted.

Another arbitrary suggestion for the contents of the slips is a space for recording the date, and weight and height of the baby. This is another note of individuality which the general diet slip can impart.

### "PURITY" OF FLUID MILKS

Various adjectives such as "clean," "pure," "wholesome," "high grade" and "Grade A" are nebulous terms with which the purveyors of milk have sought to condition the buying public and to impress them with the general concept of bacteriologically clean milk without defining what they mean by terms.

The introduction in 1939 (amended in 1953) by the U.S. Public Health Service Milk Ordinance and Code has done much to define what is meant by the ambiguous terms, and to improve the quality of fluid milk for the consumer. While this code is merely suggestive, it has no legal standing unless it is adopted by a given municipality, but it has done much to set a high standard for milk and dairy products which can be recognized as a goal toward which to strive. Many large cities and enterprising county health

organizations have adopted this code as an ordinance and enforce it as a local requirement.

This Milk Code is predicated on healthy herds, high standards of cleanliness in the dairy producing farm, specified hygienic procedures in the processing plants, and suggestions as to refrigeration and handling by the retail and wholesale distributor. As a definition or check on these requirements, standards for maximum bacterial count of the milk before and after processing have been set and are here presented:

Bacteria Plate Count per C.C.			
Grade	Raw Milk	Pasteurized Milk	Coliform (Pasteurized)
A	under 200,000	under 30,000	10
B	under 1,000,000	under 50,000	10
C	no limit	no limit	no limit

The code provides that only Grade A and Grade B may be sold for human consumption. Grade C can be used only for other purposes.

For the application of these principles to the canning of milk the reader is referred to page 96 as to the Evaporated Milk Association's Sanitary Standards Code 53 which has been adopted by many municipal and county governmental agencies as ordinances and are locally enforced.

**Isotopes in Milk from Atomic Tests Fallout**

Because many news magazines continue to emphasize the portentous possibilities of increasing radioactive fallout from world-wide atomic tests, it would seem timely to note here some of the information available which pertains to infant foods such as milk.

During the public hearings of the sub-committee on Radiation of the Joint Congressional Committee on Atomic Energy in May of 1959, some of the following data have emerged:

- a) The heaviest fallout since nuclear-weapons-testing began is said to be settling over the United States and is being deposited non-uniformly, with heaviest concentrations in the north temperate latitudes;

b) the concentrations of *strontium-90* and other radioisotopes (*cesium-137*, *carbon-14*, *plutonium-239*, *strontium-89* and *iodine-131*) in food and animal tissue has increased greatly in the past 2 years. It is still a question as to the extent of genetic and somatic damage that may be caused by this rising level of radioactivity;

e) most milk in the world today contains measurable amounts of *strontium-90* plus that of 4 other radioisotopes from fallout. The MPC (*maximum permissible concentration*) for milk is 80 S.U. (*strontium unit is one micromicrocurie of strontium-90 per gram of calcium*). Sample tests in various American cities of the respective milks varied from 2 S.U. to 16, and milk in St. Louis, Mo., is currently showing about 20 S.U., one of the highest levels in the United States.

d) other foods tested are generally well below their MPC although some single samples have exceeded the permissible level especially for grain; common frozen vegetables had an average content of 7.3 S.U. In an analysis of human bones it was found that those of North American adults averaged 0.07 S.U., and of children in this geographic area was (birth to 4 yrs.) found to be 0.67 in 1956 but double that in 1957, to 1.38 S.U.

These data are reported here to illustrate that we are living in an atomic age and which affects human nutrition. It may be that other criteria than bacterial count, fat and solids content may be necessary to qualify milk in the future. One has the impression from the reports of the various commissions and atomic scientists that much is yet to be learned as to the harmful effects of radioactive concentrations at present, and that many questions remain to be resolved in the realm of maximal or minimal permissible concentrations.

(The data here presented were summarized from the reports of studies of W. E. Eckelmann *et al.* from the Lamont Geological Observatory, Columbia University as appearing in *Science*, Feb. 1957 and Feb. 1958; and from the public hearings of the Joint Congressional Committee on Atomic Energy as reported by MD, Medical Magazine, June, 1959, pages 57 and 58.)

## THEORY OF ENTEROTOXINS IN CANNED MILKS

Despite the sterilization of milk during the procedures of processing milks it has been theorized that although the viable organisms have been killed, the products of their metabolism (*exotoxins* and *endotoxins*) as well as the dead bodies of the bacteria might have deleterious effects by means of the still-live toxins or by the allergic reactions from the protein of the bacterial body. These substances, because of their effect on the intestinal tract have been called *enterotoxins*. Much more is made of this hypothesis than can be proven by demonstration or experiment. When these entities are present in a food, the quantities necessary to produce poisoning are too minute—and are only 1 part per thousand million. There are other more demonstrative proofs which makes the presence of these substances in milk unlikely.

Factors which mitigate against production of toxicogenic bacteria in processed milk may be here summarized:

1. Milk as it comes from the cow is not an ideal medium for the growth of toxicogenic organisms because of the low temperatures at which milk is handled and the low pH of the milk (153, 39).

2. The normally-present lactic acid producing bacteria create a medium which is incompatible to putrefactive (toxin producing) organisms, and from the time of milking to delivery at the plant there is insufficient time for the relatively slow-growing toxicogenic bacteria to develop.

3. The heat to which evaporated milk is exposed in sterilization is sufficient to inactivate any bacterial toxin that might be present (119, 94).

4. Since a plant processing evaporated milk receives milk from hundreds of farmers contributed by thousands of cows, a dilution factor is present which would obviate to an infinitesimal amount the quantity of toxins necessary to produce constitutional effects (153).

5. The human gastrointestinal tract has defenses against the absorption of many toxins ingested and are destroyed in the mucosa of the intestine or may be detoxicated by the liver (93).

6. There is no proof that the proteins synthesized in bacterial cells are anymore likely to be harmful than those produced in the

growth of any other plants. In any case the amount of bacterial tissue in sterilized foods could be measured only in parts per million.

Thus, the weight of evidence is against the injury or intoxication from enterotoxins for any infant being fed sterilized canned milk. If such a possibility exists scientific investigation will have to be presented to point up such specific a) evidence of the presence of such toxins and b) proof that they are actually injurious in extreme dilution.

### PRESENCE OF ANTIBIOTICS IN MILKS

Penicillin is widely used to treat mastitis in cows and from this use it contaminates a high percentage of American dairy products. In 1948 there were complaints from the dairy industry that the presence of penicillin in milk (1 unit per cc.) completely inhibited cheese-making strains of bacteria (70). It has been suggested by many authors but only by inference, that penicillin could be used by unscrupulous dairymen to lower the bacterial count of substandard milk. Many articles have appeared in the non-medical literature reporting penicillin levels in commercial milk samples, measurable quantities being found in as high as 96% of milk samples tested, and as high as 550 units per quart of milk (180). Efforts have been made by the Food and Drug Administration to recommend that milk containing antibiotics be considered as adulterated, and legislation to this effect has been introduced in some states.

The only harm which such milk could inflict on infant consumers of milk is that in the realm of producing sensitivity with a resultant allergic reaction if later penicillin might be used therapeutically, or the setting up of various chronic allergic states like urticaria. The fact that some of the reactions have been due to the previous sensitization to penicillin with a flare-up upon ingestion of dairy products has been shown by Zimmerman (192). By the injection of an enzyme *penicillinase*, which renders penicillin in the body nonantigenic and nonantibiotic, the existing antigen of penicillin can be completely neutralized. On the further taking of dairy products the original allergic reaction is again initiated.

In the author's experience very few reactions to penicillin are seen in infants or young children despite its use in them for specific bacterial infections and under the assumption that they have been "contaminated" by milk from cows having received penicillin. It is presumed that these reactions are complicated allergic phenomena which must be common in adults but that infants and children have not lived long enough to acquire these intricate responses. The subject is mentioned here because there are frequent references in the literature to the possibility of milk impregnated penicillin and its deleterious effects in infant feeding. To the author's knowledge, this has not been a problem of great moment to date.

#### DEFINITION OF VITAMIN UNITS\*

The practice of expressing the strength of a vitamin preparation in "units" is a relic of the days before isolation of the pure chemical substance. Units represent the first approximation attempts at dealing quantitatively with the new factor in question, and were a convenient device to express the activity of a preparation containing an unknown amount of an uncharacterized material. The availability of crystalline vitamins made it possible and desirable to work in terms of milligrams or micrograms of the pure substance.

The accuracy of any assay is enhanced when a standard product is available for comparison. Standard vitamin preparations were first made available by the Permanent Commission on Biological Standardization of the Health Organization of the League of Nations and distributed through National Control Centers to qualified investigators. Its functions have been assumed by the Expert Committee on Biological Standardization of the World Health Organization. These standards are widely used for research and to prepare working standards for use by manufacturers and enforcement agencies. International standards have been established for vitamins A, B<sub>1</sub>, C, D and E. An "International Unit" is, by definition, based on the activity of an International Standard preparation. The United States Pharmacopoeial Con-

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\* (Taken completely from *Nutritional Data* 3rd Edition, 1958 (121))

vention has been designated as the Control Center for the United States. Its Committee on Reference Standards has extended the work of the original Commission until USP standards for ascorbic acid, calcium pantothenate, choline chloride, nicotinamide, nicotinic acid, pyridoxine hydrochloride, riboflavin, thiamine hydrochloride, eight "essential" amino acids, vitamin A and vitamin D (forms for both rat and chick assay) are now available. (Address USP Reference Standards, 46 Park Ave., New York 16, N. Y.) When an International Standard exists, the U.S.P. standard is compared and brought as closely as possible into agreement. Therefore, a "USP unit" is equal to an "International Unit."

The existence of adequate standards has proved a boon, both to research workers and to Federal and state control officials.

### **Vitamin A**

1 I.U. = 1 USP unit = the vitamin A activity of .344 micrograms of crystalline vitamin A acetate, corresponding to .30 micrograms of vitamin A alcohol.

### **Provitamin A: beta-carotene**

1 I.U. = 0.6 micrograms of beta-carotene. The International Standard is a solution in vegetable oil, containing 200 I.U. per gram.

### **Vitamin D**

1 I.U. = 1 USP unit = the vitamin D activity of 0.025 micrograms of crystalline vitamin D<sub>3</sub>. Products assayed against this new standard (official May 1, 1951) will have only 93.4 per cent of the unitage shown when assayed against the last USP Cod Liver Oil Reference Standard.

An even greater difference is shown when the new USP Standard is used for assay of chicken feeds. Products assayed against the new standard show about 75 per cent of the unitage shown when assayed against the last USP Cod Liver Oil Reference Standard. In order to differentiate between the present A.O.A.C. Chick Unit, and the new Unit which is 33 per cent larger, the term "International Chick Unit" has been adopted.

**Other vitamin units**

The activity of other vitamins is expressed as the weight in milligrams or micrograms of the various chemically pure materials.

One still occasionally encounters values for vitamins other than A and D listed in "units." For reference use, we list these below.

Thiamine: 1 I.U. = the thiamine activity of 3.0 micrograms of crystalline thiamine hydrochloride.

Ascorbic acid: 1 I.U. = the vitamin C activity of .05 mg. of *l*-ascorbic acid.

Vitamin E: 1 I.U. = the vitamin E activity of 1 milligram of synthetic, racemic *alpha*-tocopherol acetate.

*Whenever a textbook is written of educational worth, you may be quite sure that some reviewer will say that it will be difficult to teach from it. Of course it will be difficult to teach from it! If it were easy, the book ought to be burned for it cannot be educational. In education, as elsewhere, the broad primrose path leads to a nasty place!*

ALFRED N. WHITEHEAD  
(*Aims of Education*)

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